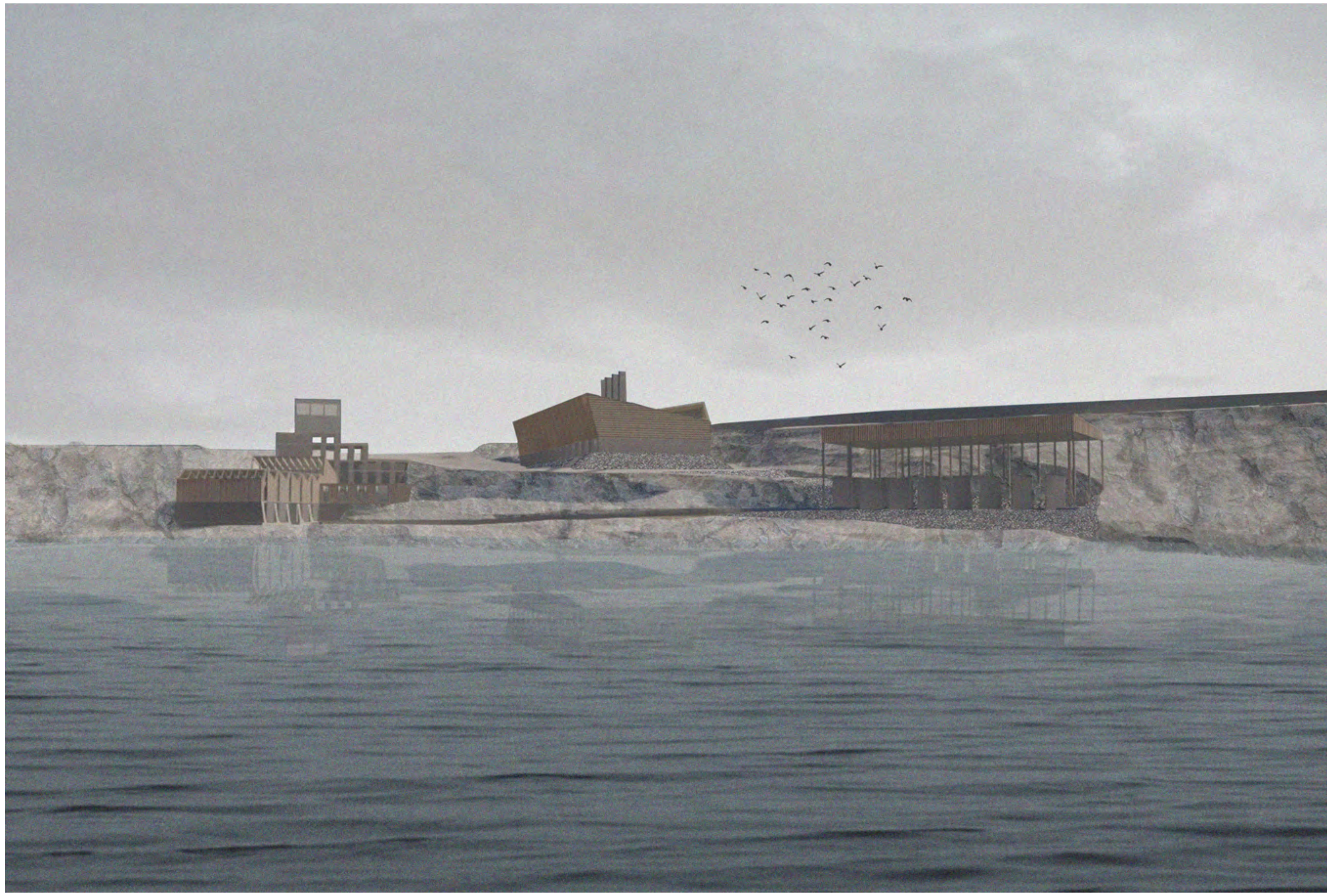
GROUNDING ARCHITECTURE

An Investigation of the Disrupted Condition in the new age of the Anthropocene



Bachelors of Architecture 2022/23

Moya Cowley

CONTENTS

DEFINITONS			5
INTRODUCTION			6
1.	THE DISRUPTED CONDITION	The Layering of time within the Tolka Valley	6
		The Value of our Soils	10
		The Critical Zone	13
2.	GROUNDING ARCHITECTURE	Reciprocal Building with the Earth	15
		Understanding the Material Narrative	16
		Soil as a Regenerative Resource	22
OBJECTIVES			23
3.	THE EXHAUSTED CONDITION	Huntstown Quarry	24
		Engaging with our interference	29
		Site	31
4.	THE NEW CONDITION	Brief	37
		Form	43
		Structure	60
REFLECTION			70
BIBLIOGRAPHY			71
TABLE OF FIGURES			74
APPENDIX			76

ACKNOWLEDGEMENTS

Johanna Cleary and Calbhac O Carroll; Thank you for your guidance throughout this semester. Your constant support to push the boundaries of my design and thinking made my thesis exploration such an enjoyable experience.

Sima Rouholamin; Thank you for the time and effort you put into making our fifth year experience run so smoothly. It will truly be one to remember.

My Family; Thank you for your unwavering support throughout my studies, I will be forever grateful.

"When we build, we either contribute to or counteract dominant processes of change."

(Islam et al., 2022)

DEFINITIONS

ANTHROPOCENE

"The current geological age, viewed as the period during which humanactivity has been the dominant influence on climate and environment." (The Oxford Dictionary, 1992)

THE DISRUPTED CONDITION

A landscape that has been subject to manmade intervention therefore cannot conduct itself within its natural systems.

INTRODUCTION

As architect's, we are continually made aware of the importance of understanding our practice with respect to the past. With our entrance into the era of the Anthropocene comes a new understanding of our history. How human and earth's pasts have converged to become one. (Kahn & Burns, 2021) Historically, architecture has been a showcase of human ambition and achievements, but with these triumphs an damaging undercurrent is present. The built environment is currently responsible for 39% of greenhouse gas emissions (Calder, 2022) on our warming planet with global material supply chains ever expanding in linear directions to deliver cheaper imported products with no focus on tracing a full circle. While our construction has always involved extraction from the earth's stores by moving resources from one place to another, contemporary ways of building with mass produced concrete and steel and petrochemicals have transformed the world in many damaging ways. (Islam et al., 2022) Not only at the place of formation but also the many disrupted landscapes of material extraction, processing, transportation, holding and disposal. In today's world, buildings are as much designed by these pre-existing supply chains and industrial practices as they are by designers.

From my preliminary study of the Tolka Valley Park, I discovered its disrupted history of material extraction and disposal leading to an understanding of the ground as a living thickness, the man made soil that covers most of earth's skin itself, a disrupted condition. Establishing a deeper understanding of our soils will in turn ground us within nature, allowing the practice of architecture to grow and learn from our environment's regulator. There should be no conflict between us and nature. Human interventions have become their own force of nature affecting the earth systems. It is time to recognize that we are a part of the landscape, not the 'other'. A place with unlimited resources, where we dump waste material in perpetuity. Natural processes and human artifices have combined to become one in a complex new being. (Kahn & Burns, 2021)

To meet current climate targets centered around carbon neutrality, we must consider new approaches to construction. This thesis idea explores material production that is engaged with the chain of extraction and disposal. We must consider natural materials such as earth, stone and timber but as part of a regenerative cycle in order to radically expand the obligation of place making into the landscape. For architecture to remain a major part of human life, we must begin to engage with what is below our feet, mediating between the grand ambitions of human intent and the shadowy forms of natural processes.

This thesis idea has been tested through the design of an earth block manufacturing campus, located within the exhausted North Quarry of the Huntstown Quarry. My building seeks to transform this man made disrupted site into a productive landscape using regenerative materials sourced from an existing waste stream as a proposal for addressing our interference with the earth's skin.

THE DISRUPTED CONDITION

THE LAYERING OF TIME WITHIN THE TOLKA VALLEY PARK

The reading of the Tolka Valley park became a matter of deciphering the interlocking natural and anthropic sedimentary processes that make up its disrupted ground condition. Natural landscape reshape is something we have experienced since the beginning of time as geology has shifted through the deposit of matter. Matter's origin landscape is always being reshaped by the earth. The River Tolka has continuously shifted the limestone bedrock depositing middle coniferous limestone known as 'calp limestone' along its meandering edges. (Ireland, EPA Maps) This type of stone consists of black limestone and shales of boulder clay giving it an earthy character. This was the Tolka Valley Park's original natural reshape. It was not until man got involved that this matter became material.

The standing reserve of 'calp' limestone underneath the Tolka Valley Park was utilised in the eighteenth century when it became one of the earliest stone building materials for the Normans. Quarried in other places such as Crumlin, Rathgar and Donnybrook, it was a cheap building material due to its proximity to the city and its closeness to the surface and was used in much of North Dublin's streetscape. (Jackson, 1993) However, the heavy presence of shale in the rock meant that the rock blackened overtime when exposed to the elements. Poor quality 'calp' quarried from Donnybrook eventually released its mud onto the streets. It was then that 'calp' limestone shapeshifted to become the hidden stone of Dublin, used as the construction material for many of Dublin's historical buildings such as the GPO, Parliament House, Custom house and the old library in Trinity that were then covered with neater Portland stone or leinster granite. (Jackson, 1993)

Fig 1; Histroical image of the Fingal Landfill within the Tolka Valley Park (Heritage, Glasnevin, 2015)

The closing of the Finglas quarry led to the development of a local authority landfill in its place in the 1930s which functioned until the early 1970s closing before the EU Framework Directive was introduced. This means the historic landfill underneath the park is unregulated as it was never designed to be a landfill. This disrupted landscape was not correctly capped, with just a layer of topsoil placed on top, to create the Tolka Valley Park. There are no systems to treat effluent thus leachate is created from groundwater seepage within the park's soils.

Minor interventions have been added to the river's valley in order to contain this contamination such as the introduction of willow trees to hinder soil movement along its steep banks and permeable gravel filtration trenches at the valley's base to help improve the river's water quality. (Pranvera, 2018) Despite these actions, the soil's contamination can still be seen today, seeping up through the park's pathways. From my research of the Tolka Valley Park, it became clear how we deal with these man made disrupted landscapes; we cover them up.

Fig 2; Leachate seeping up through the paths within the Tolka Valley Park

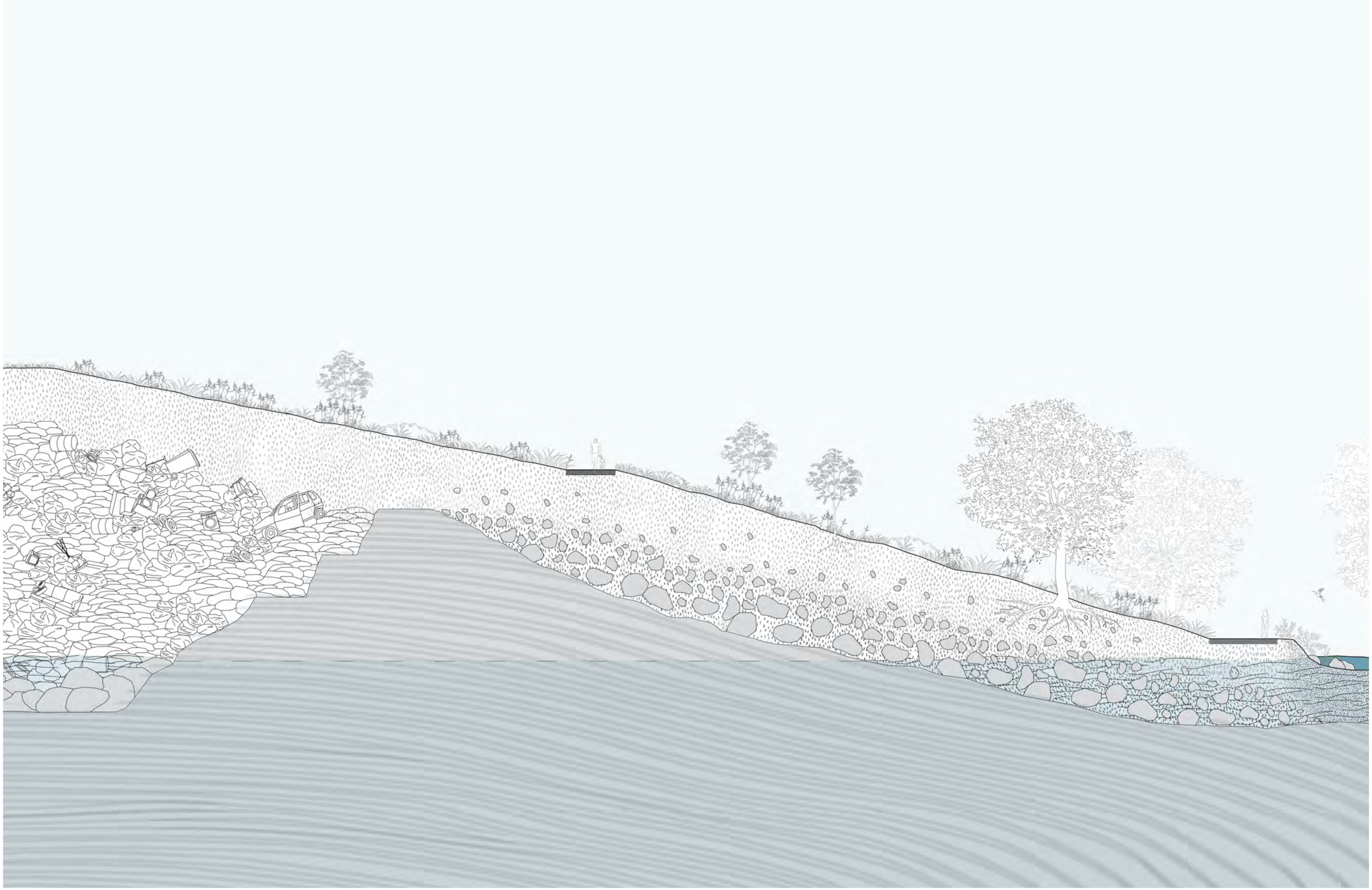


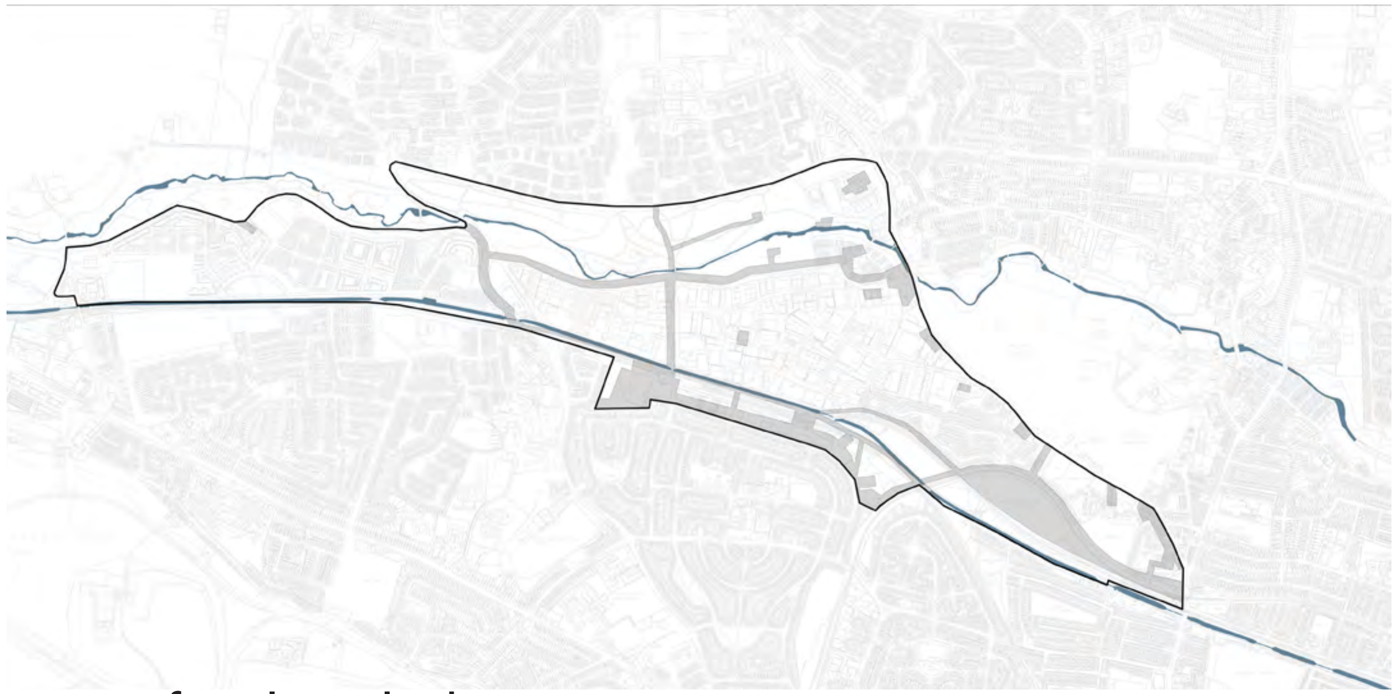
Fig 3; Section through the ground within the Tolka Valley Park showing the overlapping human and natural processes overtime.

THE VALUE OF OUR SOILS

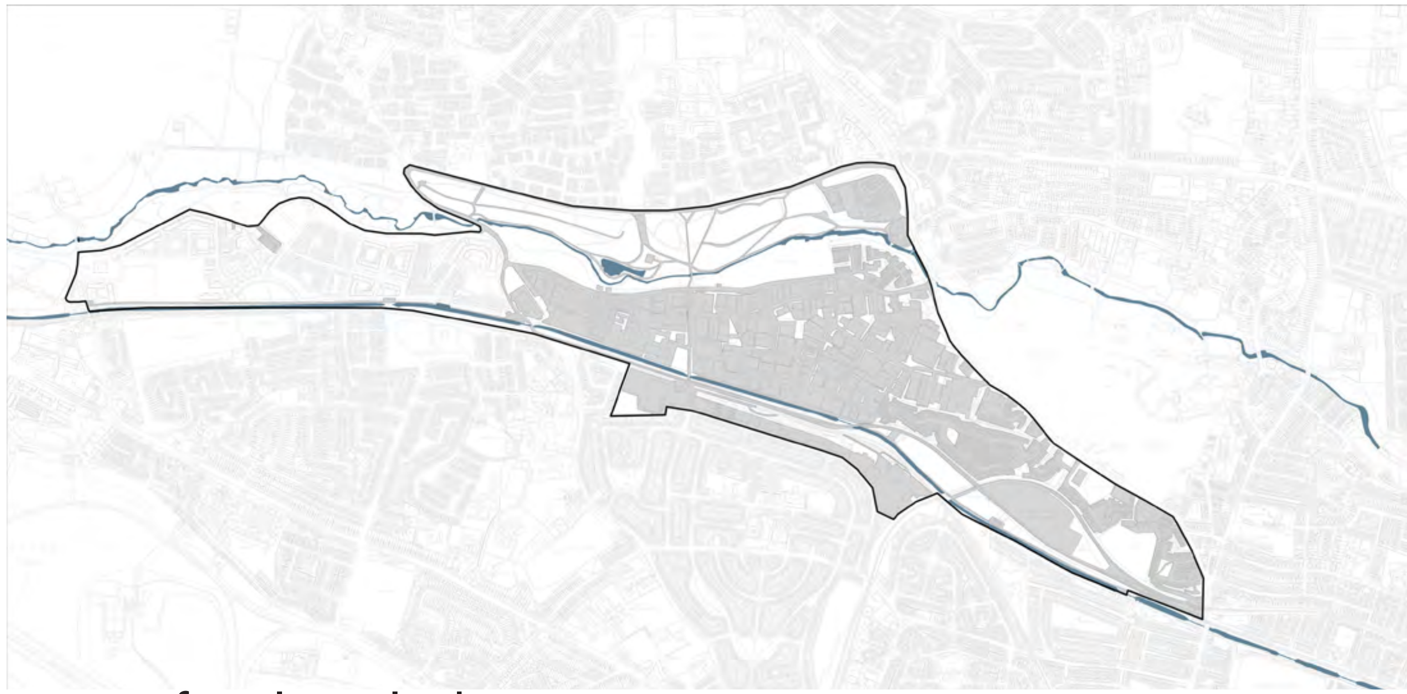
To consider urban disrupted soils such as soil found within the Tolka Valley, we must acknowledge their formation by traditional soil processes intertwined with human interventions. They are largely sealed by hard surfaces, compacted full of pipes and cables. (Oosterheerd, 2021) This sealing leads to issues of flooding and overheating within our cities as the soil's water storage capacity is diminished due to disrupted cycles. The hard surfaces are unable to absorb much heat leaving the soil underneath to dry out, degrading the soil further. The original landscape has been concealed under a layer of building sand, leaving the only place to find rich soils in urban parks. (Oosterheerd, 2021)

There is a need for soil diversity for soil to function. Our soils are made up of over one billion individual microorganisms that all play a vital part in the nutrient cycles that sustain living on earth. Its main actors, unicellular organisms, fungi and very small animals collaborate together, each a functional point in our earth's food network. It is a dynamic balanced system through a series of biotic and abiotic factors that ensure the structure of our soils, the amount of water it can retain, its provision of oxygen and nutrients for plant development. It is the regulator of our climate, together with the ocean keeping our biosphere and ecosystems in harmony within the critical zone. (Oosterheerd, 2021)

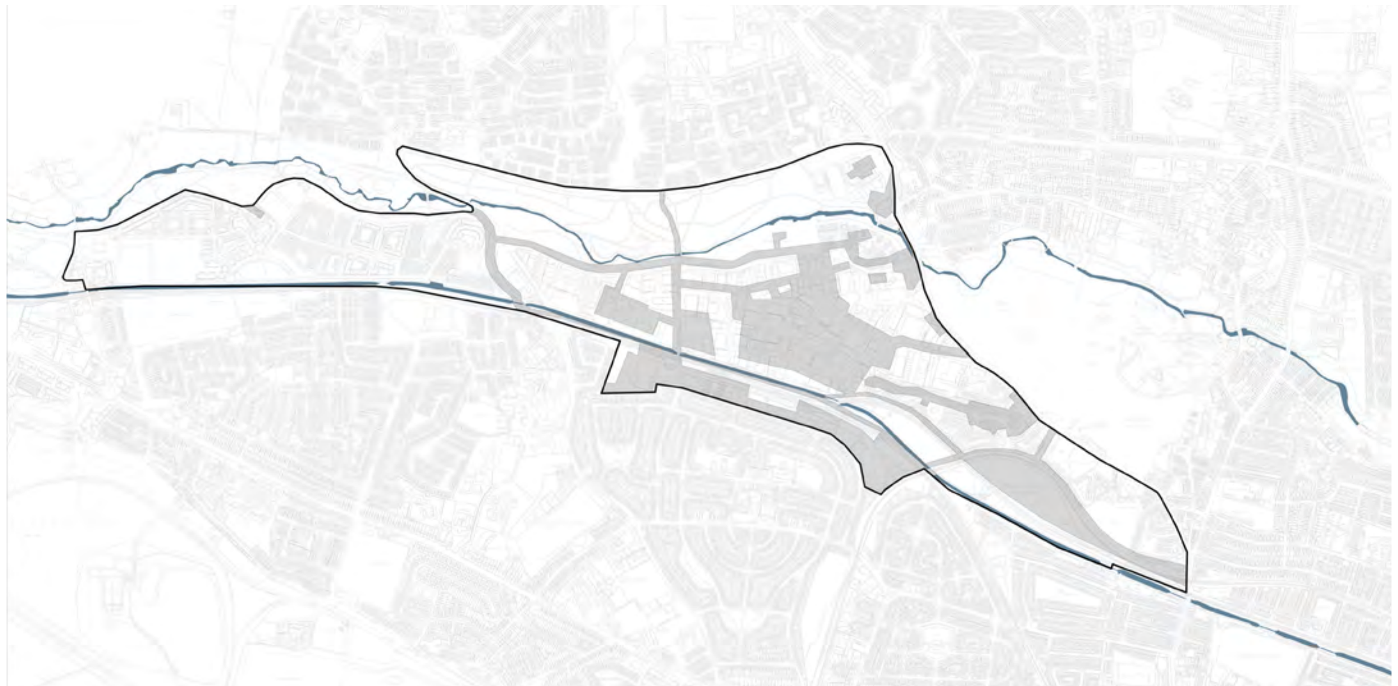
The issue of soil degradation on our planet's skin is a major factor in our need for change. Human behaviors shed soil of its organic matter at a quicker pace than nature can replenish. The FAO states "the maintenance and recovery of healthy soils on earth is the most urgent issue for humanity" (Oosterheerd, 2021) They estimate our soils have 65 years of fertility left. With 95% of our food production coming from fertile soils, it is clear the problems we will face if our actions continue. In addition, carbon is stored in the top three meters of the earth's skin. Therefore disrupting its structure not only releases this to the atmosphere but leads to more soil erosion, weakening its ecosystems. (Oosterheerd, 2021)



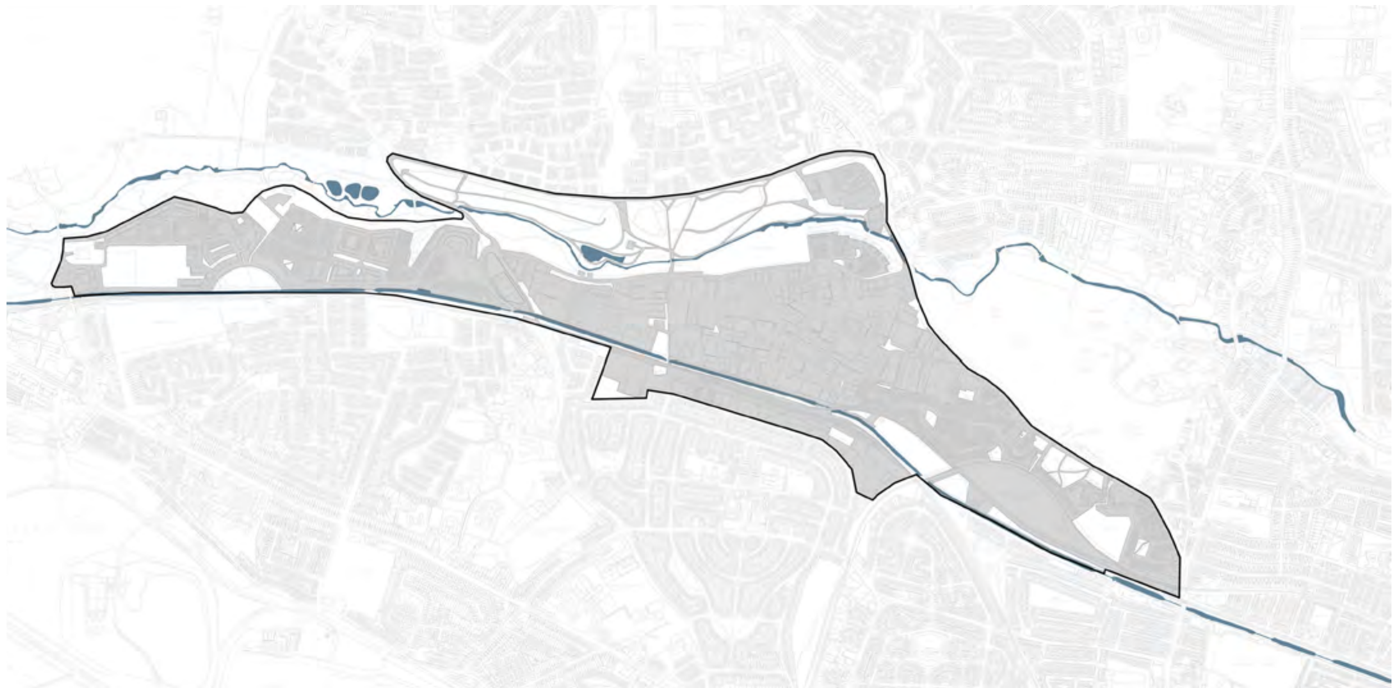
18% of soil sealed



53% of soil sealed



29% of soil sealed



69% of soil sealed

Fig 4; Maps highlighting the soil sealing overtime within the Tolka Valley Industrial Estate

Fig 5; Stage 3_Part 2 Exploration of the Soil Cycle and the use of Ground Materials within construction overtime.

THE CRITICAL ZONE

The earth's critical zone is the thin permeable top layer of the earth's skin which is occupied by living organisms. It is where we draw our water, grow our food, build our homes and store our waste products. It is an interface, shaped by weathering and erosion, that is continuously moving beneath our feet. Its dynamics, formed by the tension between the cooling of the earth's core beneath it and the heating of the earth's skin by the sun, allow it to have many functions within its various shapes and features. (Latour & Weibel, 2020)

The earth's critical zone has been disrupted by slow chronic violences' at our hands for centuries. From the excavation of Plato's cave to today's global processes of material extraction from the earth's skin. Unlike the living organisms within it, the earth evolves very slowly allowing us to believe we are doing no harm, a false notion of immutability. It is fragile and threatened by our human acts of exploitation. Understanding the critical zone within an area gives significance to the layers of time and local heterogeneity. Gaining this knowledge can be difficult as the architecture of the critical zone is poorly understood beyond its basic components. Ecosystems are frozen as objects of study within their own departments, lacking correlation between subjects hindering our understanding of a piece of land as an interconnected system. (Latour & Weibel, 2020)

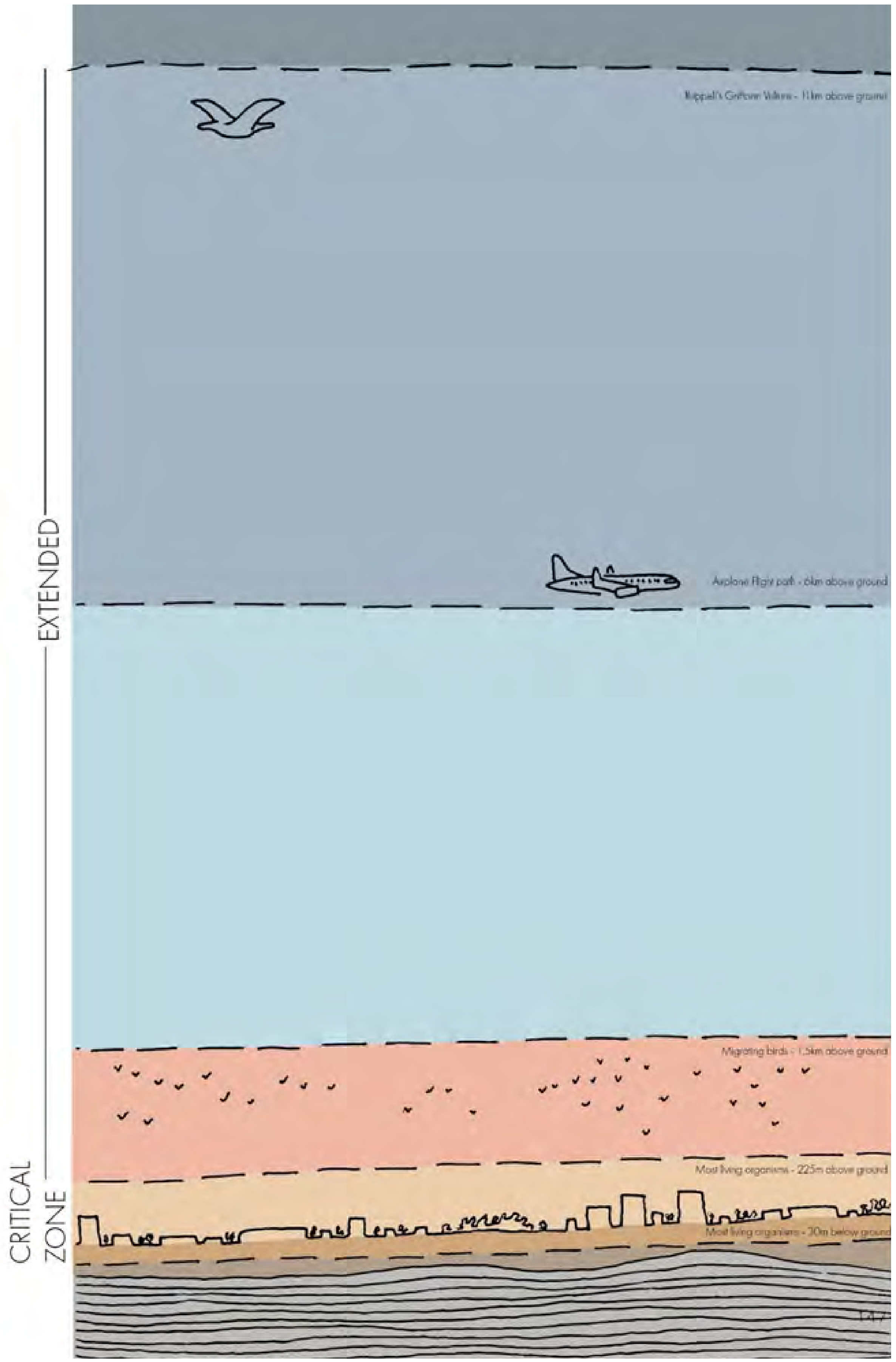


Fig 6; Sketch Diagram exploring the length of the critical zone

Within the critical zone, there is a constant tension between the earth's ecology and architecture. As Architects, we inherently do harm to the earth around us by ripping from its skin and constructing upon it. We cannot create without extraction from its stores (Editors, A.R. 2022) with at least 50 gigatons of 'matter' exploited or extracted annually. (Duperrex, 2020) This highlights our lost connection to the earth. The earth is what gives us our basic needs, shelter,, food and water yet we feel separate from it. We are in comfort because of the earth but give nothing in return. (Editors, A.R. 2022) We must understand we are all inextricably interdependent on each other within the earth's system and this is something designers should consider within their architecture in order to create cultures of reciprocity within the wider community. "If we want to grow good citizens then let us teach reciprocity". (Kimmerer et al., p116. 2015)

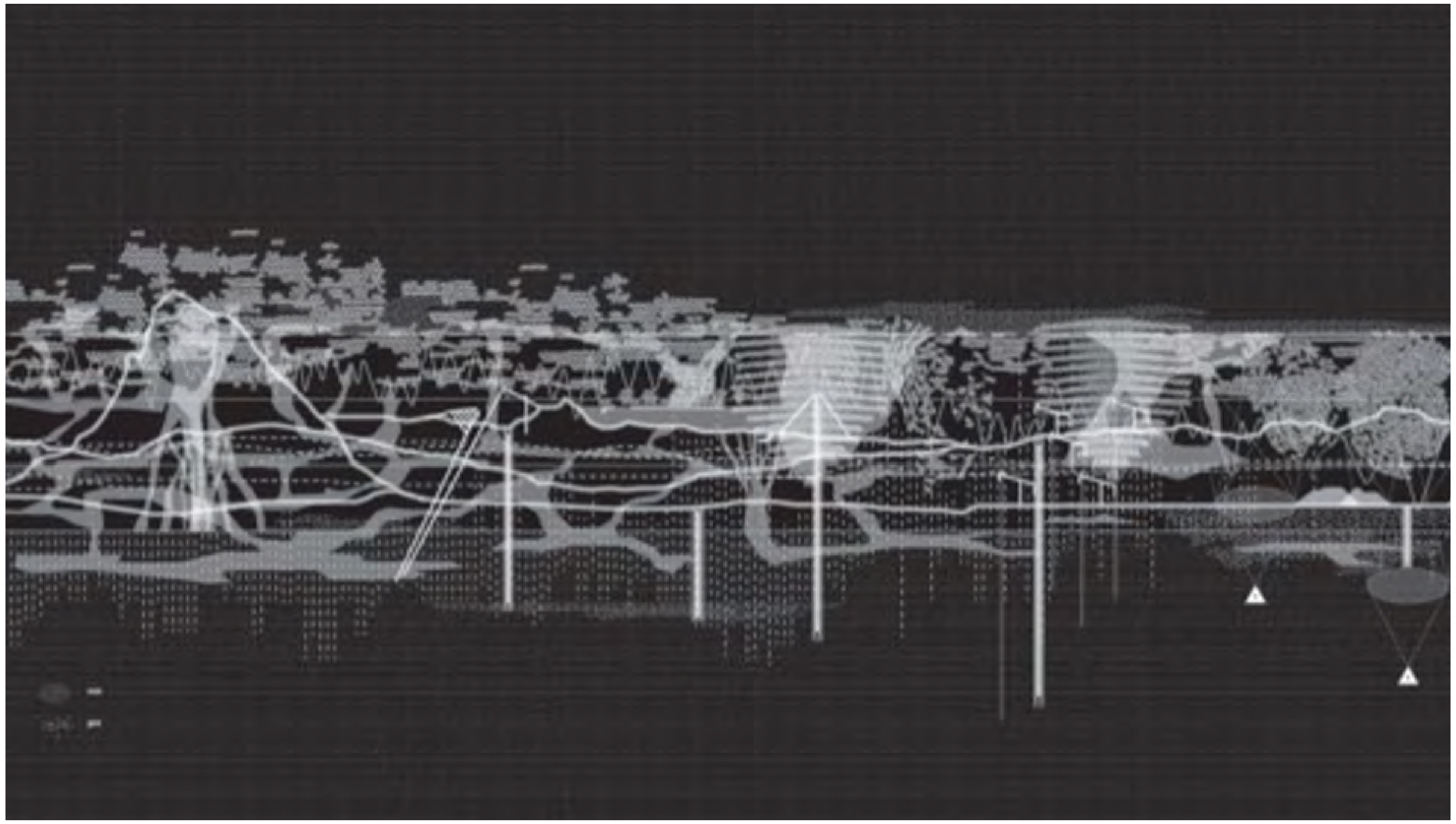


Fig 7; Cross Section of the layers that make up the Critical Zone. (Arenes, 2022)

GROUNDING ARCHITECTURE

RECIPROCAL BUILDING WITH THE EARTH

Entering the Anthropocene, post-humanist thinking acknowledges our place within the planet's system as a small component of its web of life, steaming from James Lovelock's Gaia theory that the planet is a self-regulating structure made up of interconnected systems of living organisms. (Lovelock, 1995) We are not superior to other beings within this system and must consider this in future design when demolishing the border between culture and nature. The earth is not our stage, an immobile backdrop to our civilization but a continuously moving and evolving element that is actively participating in our performance. (Kahn & Burns, 2021)

We have moved past the point of natural equilibrium between us and the earth and unfortunately, we are too late in our acknowledgement of this. There is no point of return to the Holocene as small actions will not suffice. We must reconstruct ourselves within the earth's system from the centre of dominance to the centre of responsibility. We are the earth's repairman, acknowledging our impact and holding ourselves accountable. (Kahn & Burns, 2021) What is needed is a paradigm swing in our theory and, while progress is being seen in other sectors, the built world remains fundamentally 'terra incognita' with our continuous use of harmful materials within global supply chains. (Kahn & Burns, 2021) Our relationship to the earth's skin provides us with countless 'natural' starting points of design, grounding architecture as one with the earth by incorporating ever changing natural matters such as clay, timber and stone (further outlined in appendix A). The use of natural materials in a reciprocal manner suggests a relationship between man and the earth, allowing us to consider the earth itself, as an architecture. (Viganò et al., 2022) We must push for a new age of material simplicity constructed on bio-based materials. Our earth's raw materials, used in a mutual way with the earth to create simple structures, constructed using modern processes.

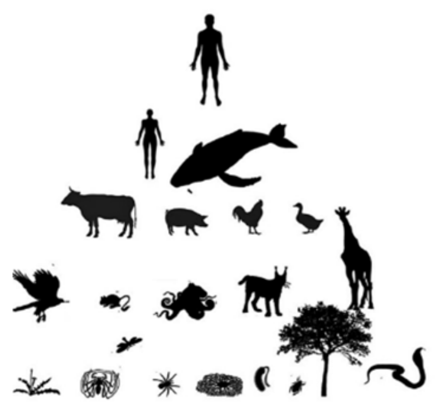


Fig 8; Diagram showing the conditioned hierarchy of species and new diagram showing our inertconnected system (Kahn, A. and Burns, C., 2021)

UNDERSTANDING THE MATERIAL NARRATIVE

While the term 'sustainable building' is broadcast widely to describe new construction, common practices still rely predominantly on heavy fossil fuel inputs such as cement processes, steel production and material transport all over the world. (Calder, 2022) Interlocking supply chains criss-cross the earth's surface, hiding the character of the material processes themselves. However, even considering this disembodied production is futile when the cultural, health and social impacts on which these processes rely are not even considered by us, the designers. We "relate to materials as abstractions to be specified, not substances to be produced".(Islam et al., supply chains, 2022) Within design, the hidden cost of materials must be valued, from underpaid labor to the harm done to the local and global ecosystems where these materials are extracted and processed. The cost of this repair never seems to be accounted for, only championing the end product while the systems that produce these materials continue to be forgotten and wiped out. (Islam et al., 2022)

If the damage from these long global supply chains was accounted for, regenerative resources could become more regarded as possible construction materials. However, in today's world, exported mass produced industrial products dominate the construction industry while lower impact materials look costly in comparison. (Islam et al., 2022) What is needed is a shift towards regional production focused on bio-based construction yet we ignore our own resources in order to provide the new. Thus, continuing the cycle of material abuse in order to obtain a front of 'sustainability' but what if we found a new way of considering material production? One that reflects all these components within their design. (Islam et al., 2022) No more iconic architecture judged as a singular object but architecture that acknowledges its impermanence and constructs that into its designs. (Lovell et al., 2020)

Fig 9; Quarry Extraction (Anas et al., 2023)

Fig 10; Manila International Container Terminal (Publisher, 2021)

Fig 11; Industrial Waste Recycling, EMR Tilbury (Eminton, 2019)

While materials that have developed over the last century have reflected an ideal of permanence, the typical lifespan of a contemporary building is fifty years. These buildings characteristically consist of a concrete skeleton enveloped in plastic and foam and can only function in their ideal state. This leads to small issues causing major repair work or even demolition. (Islam et al., 2022) A way of dealing with this issue is through the concept of building material reuse and recycling. This involves building elements being removed from the structure intact allowing for their reuse in a new building. This is a concept I explored within stage three, part one of semester one group work. Our project, 'Reclamation Realm' provided infrastructure to recover, store and resell recycled materials from surrounding building demolition that was planned to take place with the Tolka Valley Industrial estate.

Fig 12; Stage 3_ Part 1 Groupwork 'Reclamation Realm', Images of Materials found on site.

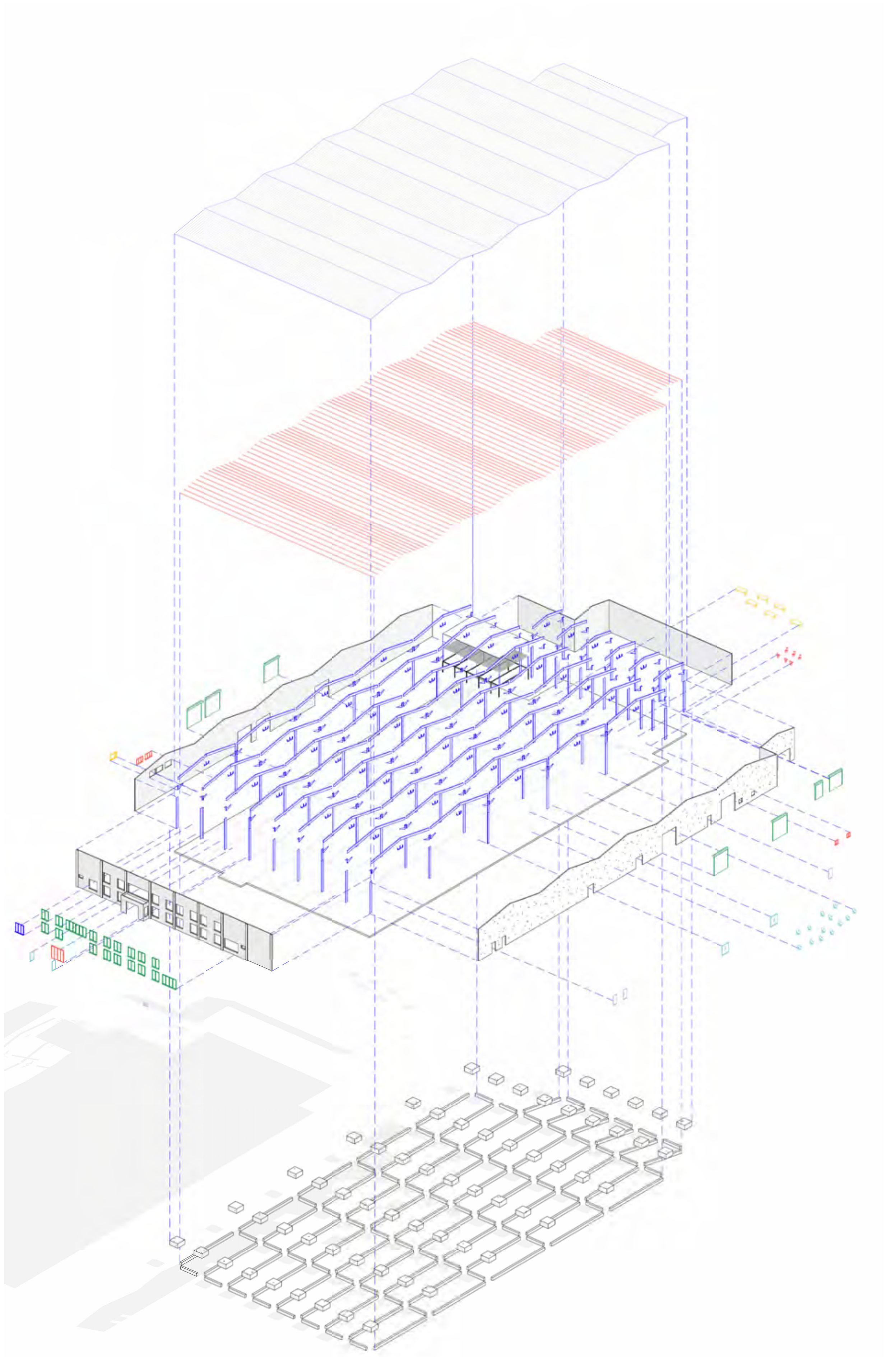


Fig 13; Stage 3_ Part 1 Groupwork 'Reclamation Realm', Colman Factory building to be deconstructed. (Korta, 2022)

Our site was located within the Dublin Industrial estate adjacent to Tolka Valley Park overlooking the Tolka Industrial estate over the river. We deconstructed five buildings planned for demolition to create a material inventory that would then be stored within an existing warehouse building on site. This warehouse would be supported by community workshop spaces and amenity spaces in order to help build a community of like-minded people who were interested in material repurposing.

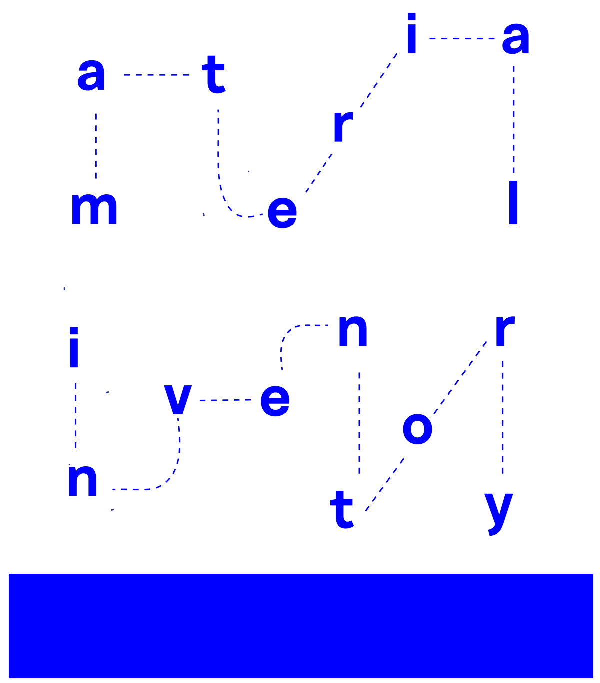


Fig 14; Stage 3_ Part 1 Groupwork 'Reclamation Realm', Material Inventory. (Quigley, 2022)

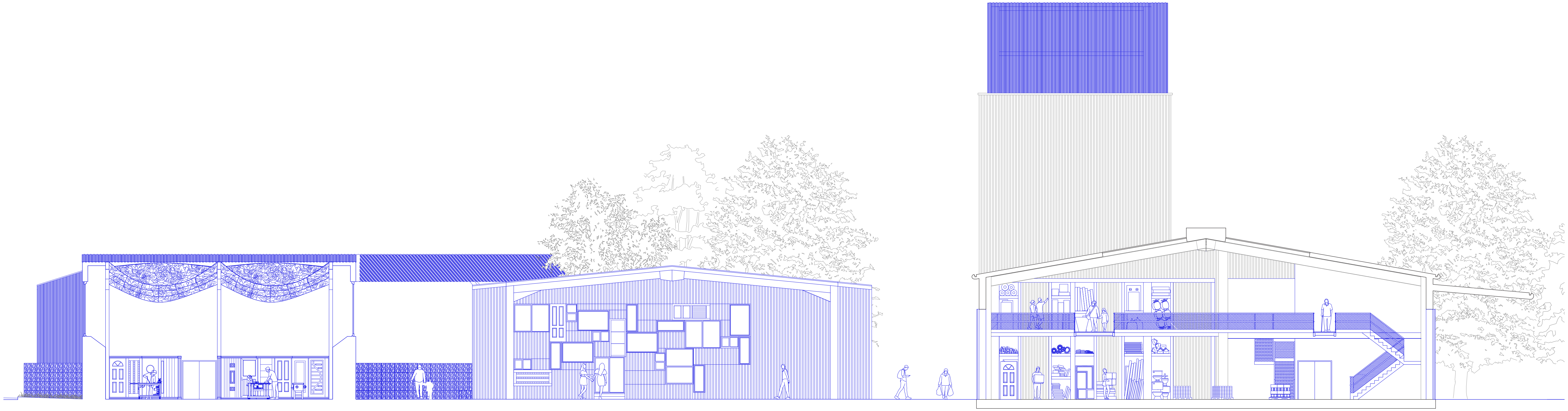


Fig 15; Stage 3_ Part 1 Groupwork 'Reclamation Realm', Proposed Site Section

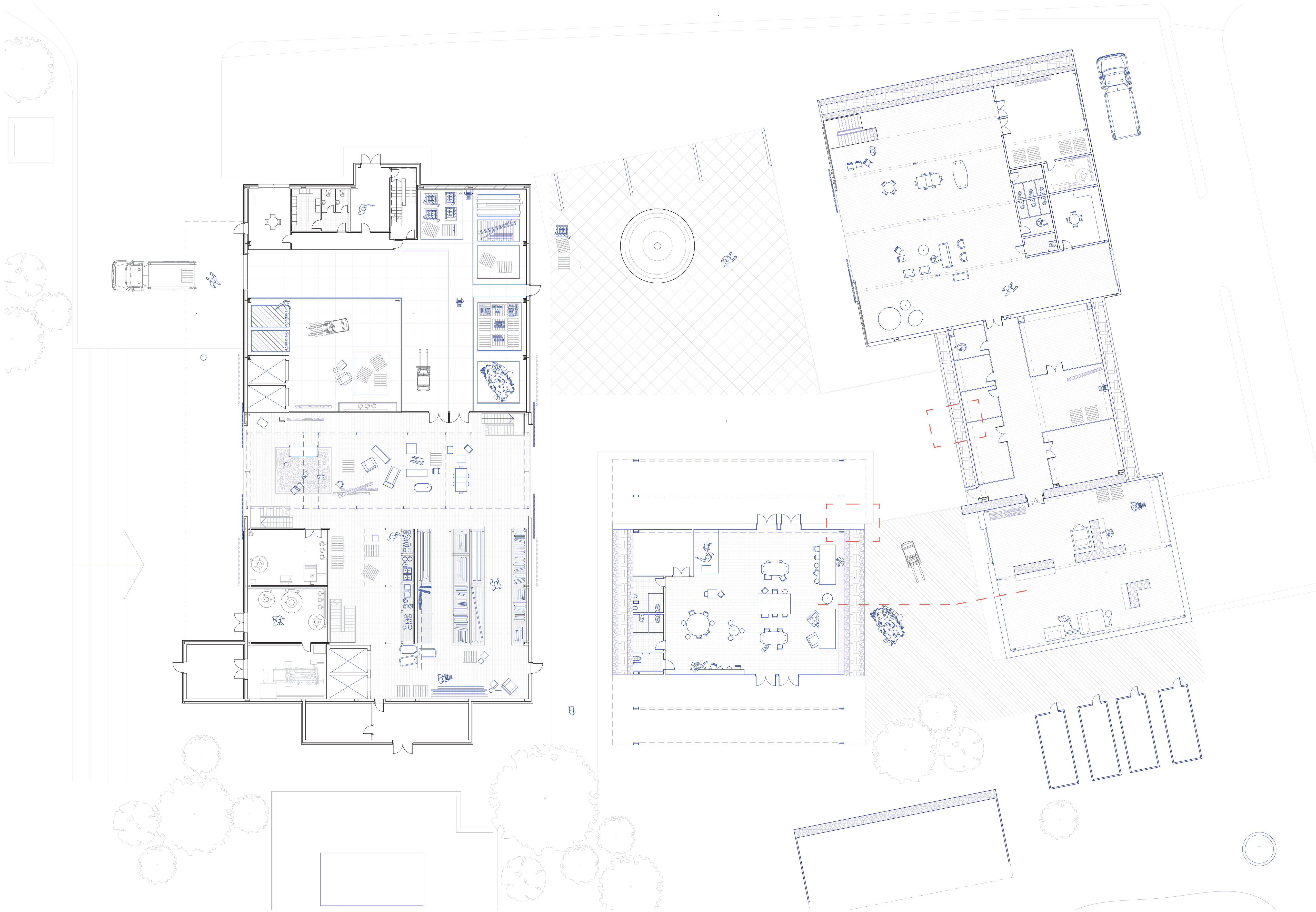


Fig 16; Stage 2_ Part 1 Groupwork ‘Reclamation Realm’, Proposed Plan (Quigley, 2022)

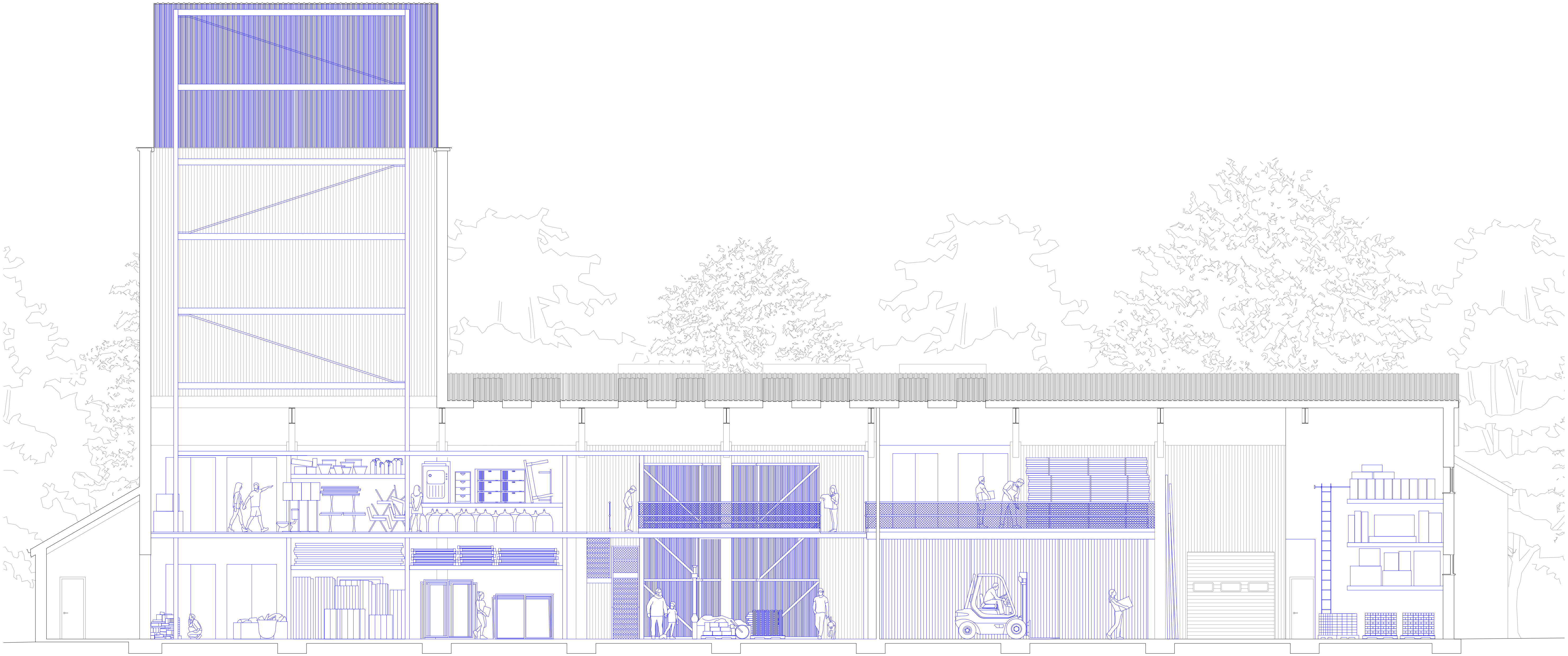


Fig 17; Stage 3_ Part 1 Groupwork 'Reclamation Realm', Existing warehouse building with new structur within.

Working with a team of architectural technologists, we developed a structure that in turn merged the concept of reuse with regenerative resources by combining recycled portal frames, concrete filled gabions and concrete blocks with thick earth walls to achieve the desired U-value of 0.18.

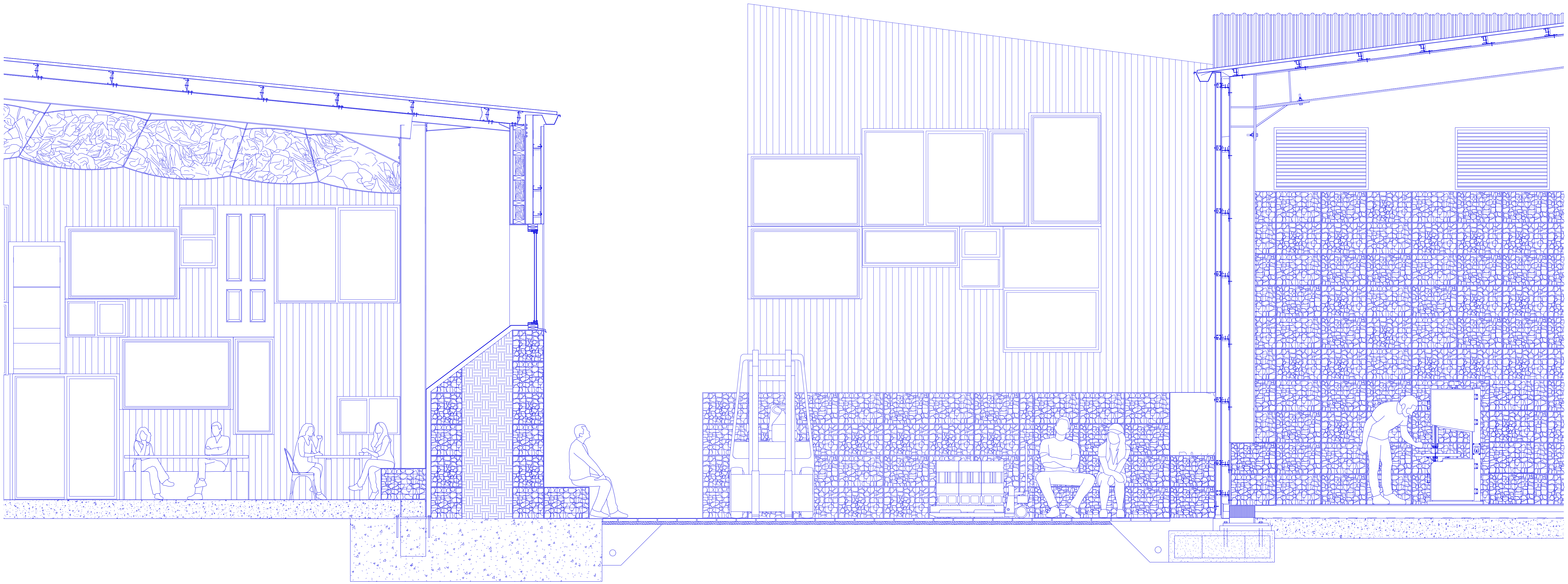


Fig 18; Stage 3_ Part 1 Groupwork 'Reclamation Realm', Detail Section through Cafe and Communal Workshop.

SOIL AS A REGENERATIVE RESOURCE

Earth by definition is the organic matter beneath our feet such as clay, gravel, sand and silt. It is abundantly available and regenerative, resulting in earthen architecture in nearly every terrestrial biome on earth. (Rael, 2009) Earth building has continually been a part of innovation within architecture with the construction of the world's first skyscrapers in the city of Shibam, Yemen in the 16th century. Called 'the Manhattan of the Desert', the cluster consisted of five hundred high-rise blocks towering up to nine stories and were made exclusively of mud brick. (Rael, 2009) Similarly in 1942, Frank Lloyd Wright experimented with innovative earth building with his Cooperative Homesteads project using a combination of rammed earth and earth berms to create a cost effective, sustainable design. Soil was excavated on site and these unearthed areas became retention ponds collecting water from the roof while the excavated soil berms rested against the rammed earth walls not only offering additional thermal mass to the building but acting as a rain screen along with the roof's cantilevered eaves. (Rael, 2009)

However, in today's modern world, earth-building is thought of as 'primitive', with efforts made to abandon its traditions in favour of the perceived hegemony of industrially produced materials such as concrete and steel. Soil's differing build up from place to place makes it hard to create material standards for processing and selling, leading to its demise as a construction material in our capitalist society. Earth is one of the few materials left that has not been subject to industrialisation. While machinery has been built to help improve the condition of the material, earth construction has prominently remained a skilled traditional practice, untouched for thousands of years. (Rael, 2009)

Fig 19; The Manhattan of the desert (MacLeod, 2019)

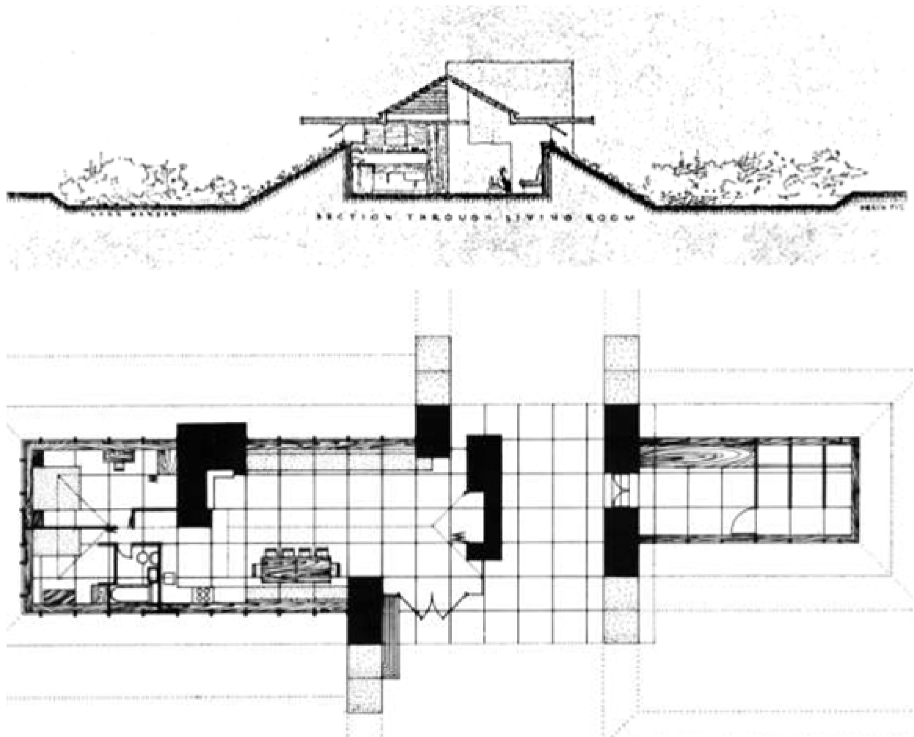


Fig 20; Frank Lloyd Wright's earth building (Admin, 2007)

Nevertheless, with our focus on sustainability in the built environment, natural raw materials such as earth have come back into focus. It is a material that responds to our environmental concerns due to its durable and adaptable qualities. (Rael, 2009) If our soil is actively nurtured instead of being subject to degradation through misuse, it becomes a living substance that is regenerative. (Islam et al., 2022) Earth building is the man-made equivalent of sedimentary rock with its application producing little embodied carbon and its structures inherently recyclable, simply fading back into the earth when abandoned. (Rael, 2009) Its form is generated mostly from aggregates such as sand and gravel bonded together by the clay content that is needed with its type of construction. With earth building, its moisture content must be carefully controlled especially in wetter climates such as Ireland. While natural and manmade admixtures such as cement or hydraulic lime can be added in order to increase its strength, with the correct recipe and application, its true durability comes from the detailing of the building. Its walls built on robust plinths and sheltered by expanded roof overhangs. (Williams, 2021) While earth building requires higher levels of investigation and testing when beginning a project in order to obtain an understanding of the accessibility and suitability of local materials, it works within a regenerative cycle that can sustain our biosphere.

OBJECTIVES

Leading from my reserach within semester one, I established a set of objectives to follow within the design stage of semester two.

1. Reciprocal Building with the Earth.

2. Understanding the Material Narrative.

3. Soil as a Regenerative Resource.

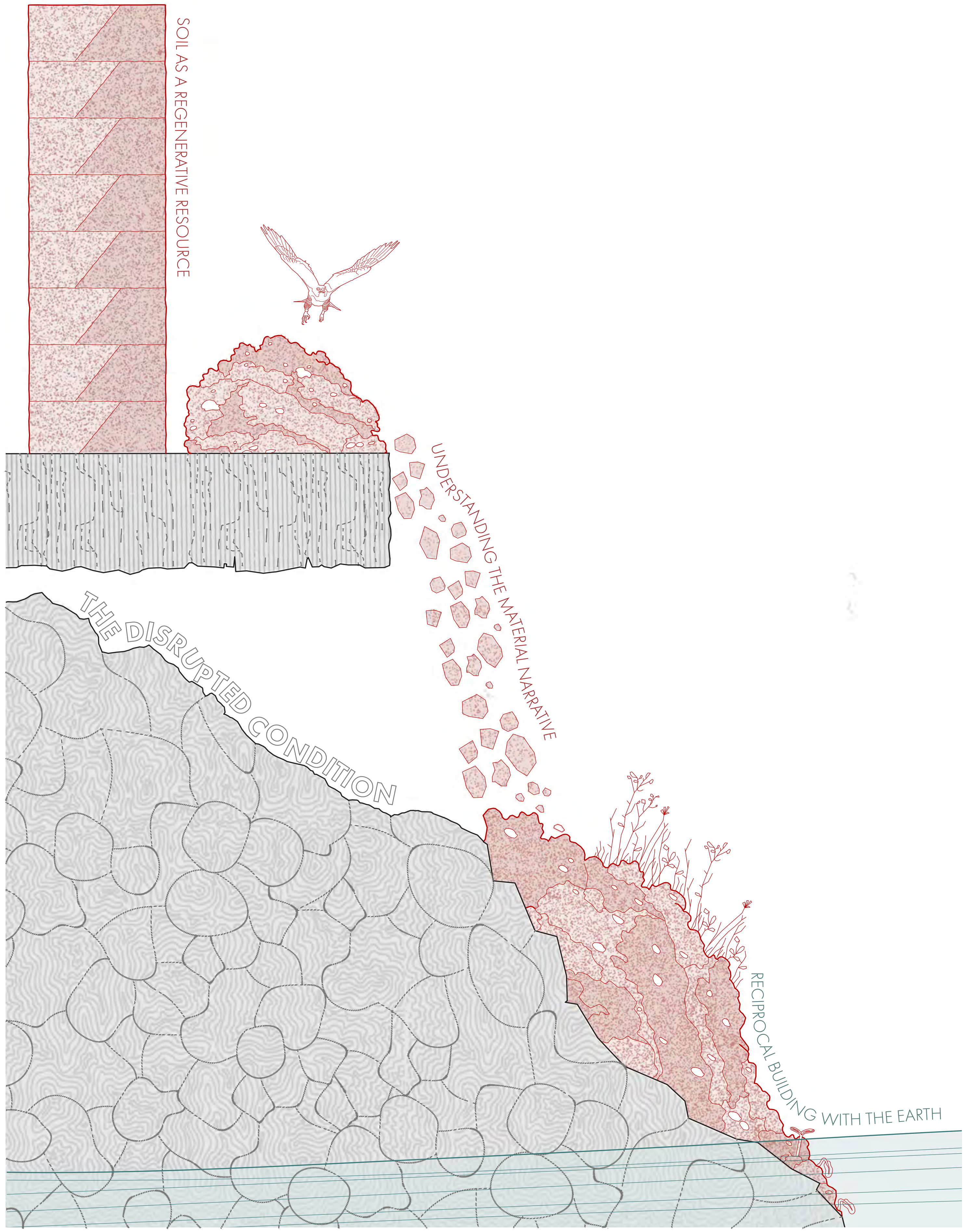


Fig 21; Objectives Image

THE EXHAUSTED CONDITION

HUNTSTOWN QUARRY

During my investigation of what is beneath our feet in semester one, my speculative research led me to Irish quarries and their lifecycle where a clear issue became apparent. When a quarry is exhausted, the process of backfilling begins where uncontaminated excavated soil and stone is used to level the ground to its original condition. This disrupted soil and stone is part of a waste stream from 'construction & demolition waste' of the surrounding area. However with our increase in construction activity within Ireland, "there is a significant shortfall in the provision of recovery sites for excavated soil and stone to enable the planned infrastructure and housing strategy to be realised." (Review of Soil Waste Managment in the Greater Dublin Area Market: Analysis Report 2017) This has led to an increase in the rate of backfilling of exhausted quarries in Ireland but this is only a short term solution with the rate of soil and stone waste expected to grow with a forecast 8,700,000 tonnes by the of 2029.

This increase in backfilling is evident in Huntstown Quarry located just three kilometres from the Tolka Valley Park where the rate of backfilling has doubled from 750,000 tonnes to 1,500,000 tonnes per annum. Construction sites within a ten kilometre radius of Huntstown, north of the River Liffey, transport their uncontaminated excavated soil to the quarry for quarry restoration. This is an active quarry that consists of four separate quarries and a cement plant on site. The North and Central Quarries are both exhausted while the West Quarry was deemed unfit for extraction and the South Quarry remains active for rock extraction with planning permission for continued quarry activity until 2034. The northern portion of the North Quarry has already been backfilled with plans to restore the full quarry back to the ground level for agricultural purposes and calcareous grassland. This is a process that will take between nine to twelve years with 9,450,000 tonnes of soil required and 472,500 HGV lorry trips needed to and from the site.

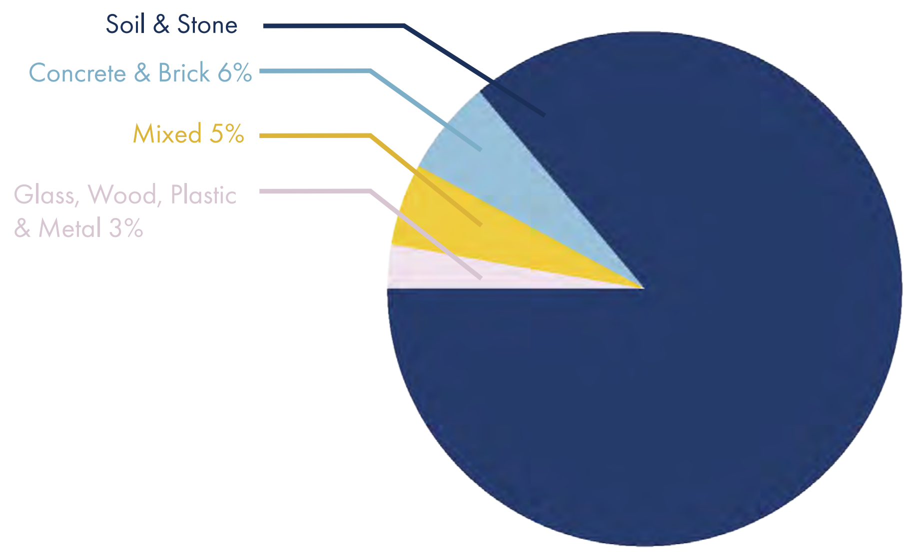


Fig 22; Construction & Demolitan Waste Ireland 2020

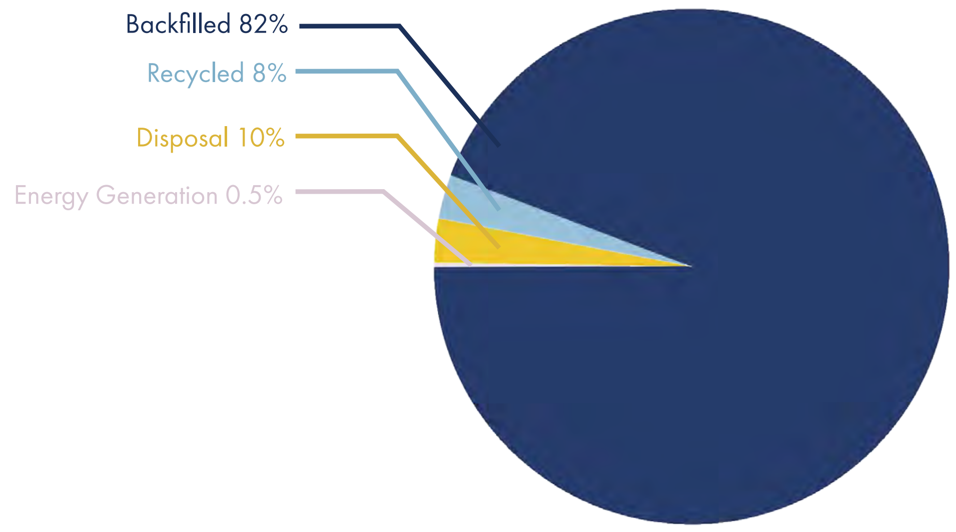


Fig 23; Where that Construction & Demolitan Waste goes 2020

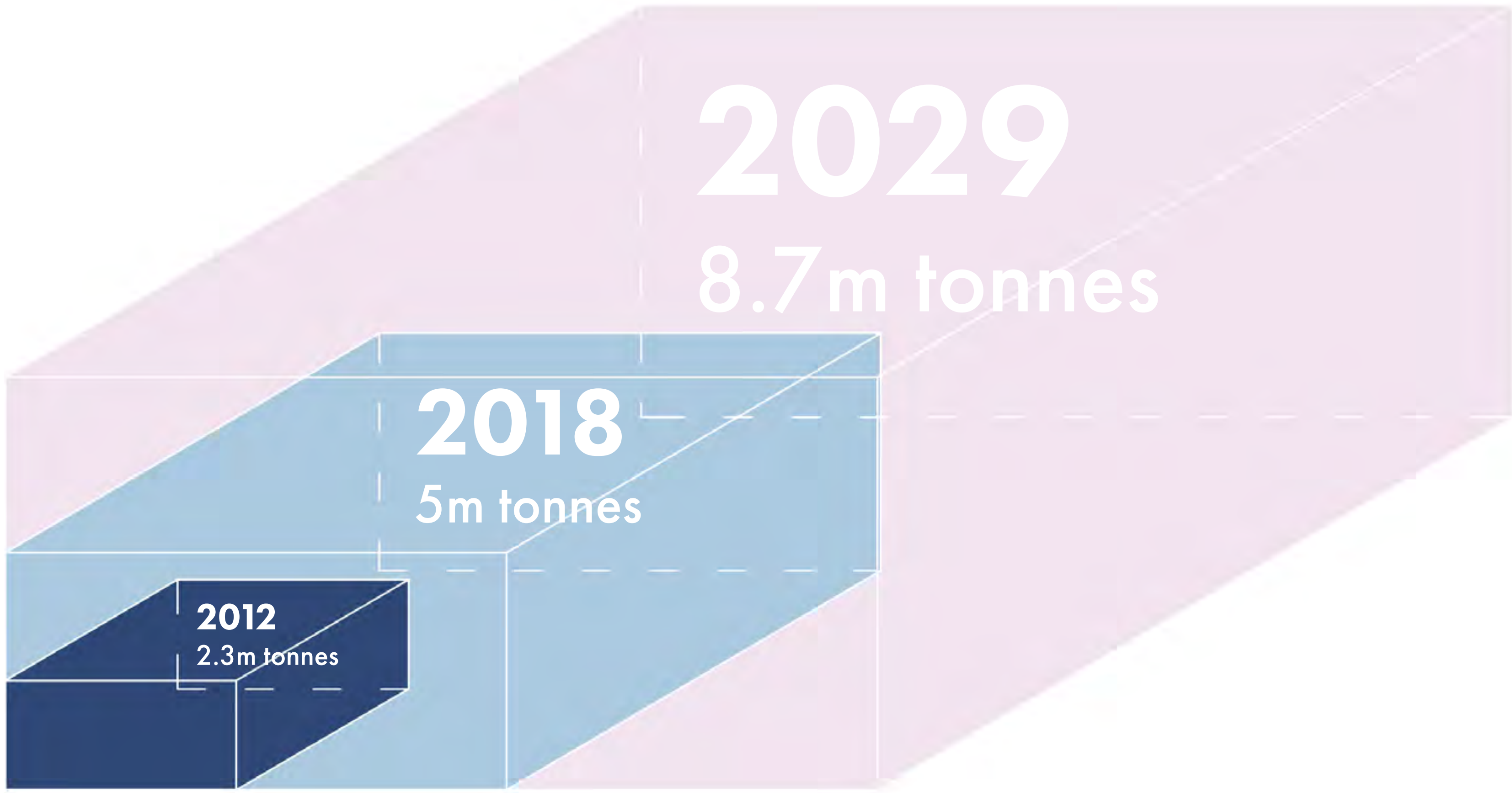


Fig 24; Predicted Increase in Construction & Demolitan Waste

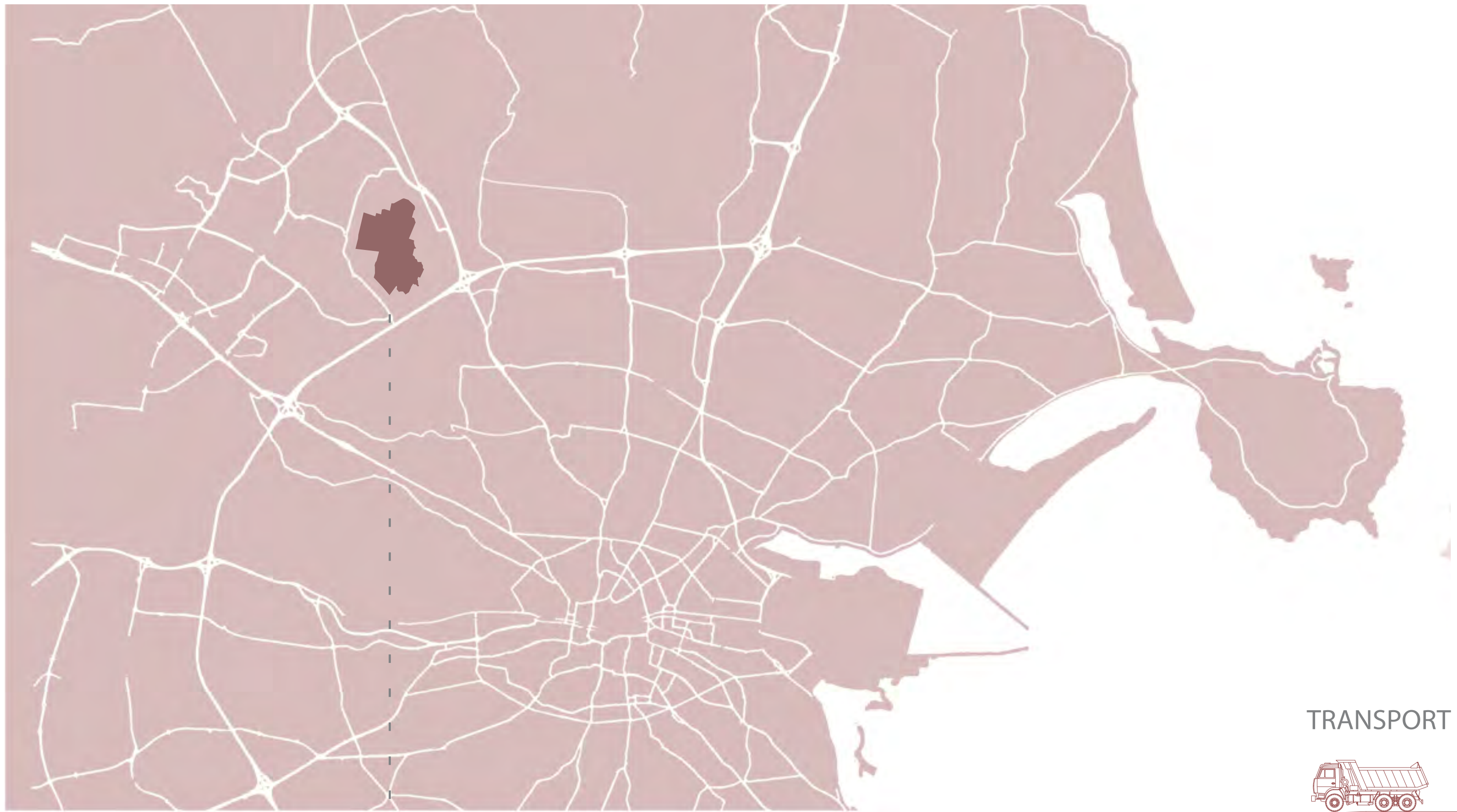


Fig 25; Site Location Map, North Dublin

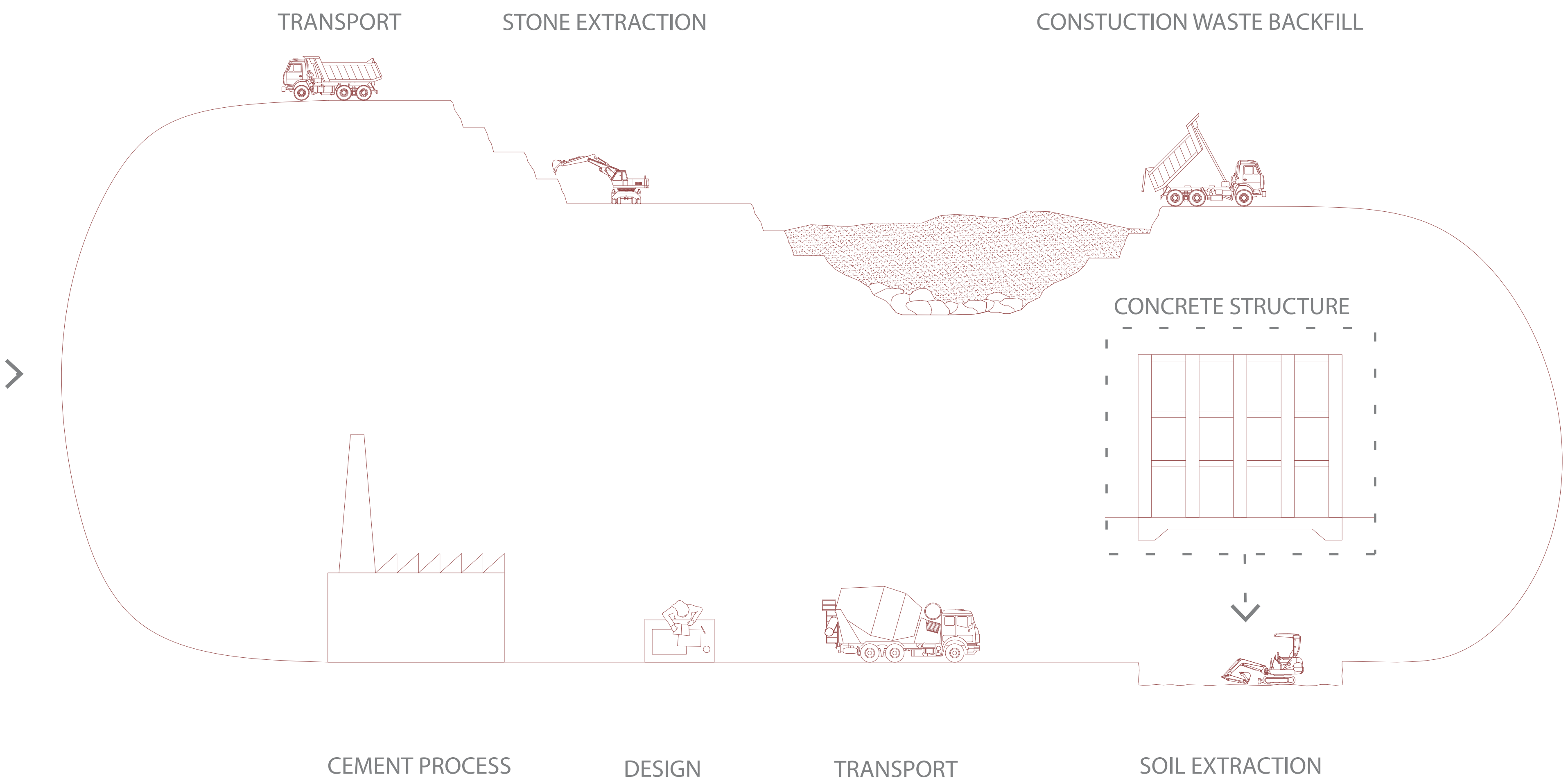


Fig 26; Huntstown Quarry Existing Process

Fig 27; Hunstown Quarry Site Plan

Quarry Exhuastion

40 years of extraction | Backfilled to ground level | 27 years of extraction | Deemed unfit

Quarry Depth

Land Use

Restored to agricultural land | Restored to calcareous grassland

Fig 28; Hunstown Quarry Site Analysis

ENGAGING WITH OUR INTERFERENCE

At the beginning of semester two, I considered if there was another option to backfilling quarries, one where we continue to work with these disrupted landscapes instead of covering them up. An alternative where we learned to live with the consequences of our activities such as the exhaustion of our landscapes and of our resources. Leaving these marks on the earth's skin to heal and rewild, while also finding a more functional long term use for the excavated soil and stone from the construction and demolition waste stream, instead of just moving this disrupted soil from place to place.

I looked for examples within Europe that had made use of this existing waste stream within their own country and discovered BC Materials in Belgium. BC Materials is a co-operative set up by BC Studios that runs public workshops around earth building. They have also tried to partly industrialise the process by using these workshops to make compressed earth blocks that are made to order. They have found that the material itself is not expensive but the labour involved in its transformation and implementation is. These workshops help to lower the cost of construction. BC Materials have found a balance between a commercial product and societal mission by not aiming for the fastest selling construction product with the maximum possible margins. Instead they aim to make a lasting and broad influence on their industry by building a community of people who are interested in the modernisation of earth construction. This approach seeks to change the building sector by creating a culture of near carbon neutral construction balanced between craftsmanship and industry.


Fig 29; Huntstown Quarry Existing Condition (Laka, 2022)


Fig 30; Milverton Quarry, Skerries subject to rewilding (McNamee, 2015)


Fig 31; Backfilling Process (Geosolutions, 2020)

I considered whether this was something that could be done in Ireland, noting that the process cannot be fully delocalised, therefore it would not be fitting to import or export natural earth products. Excavated earth from different geological layers can be mixed together to form recipes, however, careful continuous monitoring is necessary in order for these heterogeneous resources to become a homogenous building material. This is something that requires a level of local craftsmanship with knowledge of their ground build up and climate.

I propose that, instead of backfilling these excavations within the Huntstown Quarry as planned, that the construction and demolition waste stream of soil and stone that is transported to the site instead be used to make an earth product for widespread use within the construction industry.

Fig 32; Map of Europe highlight BC Materials in Brussels, Belgium and Cycleterre in Sevran, France.

Fig 33; BC Materials, Part Industrailising the process of earth blocks (Kan, 2021)

Fig 34; BC Materials, public workshops (Diederich, 2021)

Fig 35; BC Materials, Bioklas Font V (soulieres et al., 1967)

SITE

Within the Huntstown Quarry, I chose the **Northern Quarry** as the testing site for my thesis as it was the next quarry proposed to be restored to ground level. The first issue to deal with within the quarry was **water.** The quarry floor is nearly forty meters deep. The water table is currently being depressed down below its natural level in order to allow for extraction along its floor. The water is collected through wells and gathers within sumps on the quarry floor, this is then mechanically pumped out of the quarry to ground level, where it is treated in polishing ponds before filtering to surrounding tributaries. This process is done in each quarry with the northern and central quarry leading to the Ballystrahan stream and onto the River Ward and the southern quarry filters to the Scribblestown Stream and on to the River Tolka.

In keeping with my first objective, reciprocal building with the earth, I would allow this water table to rise back to its natural point creating a body of water within the base of the quarry, thirteen meters deep from the quarry floor.

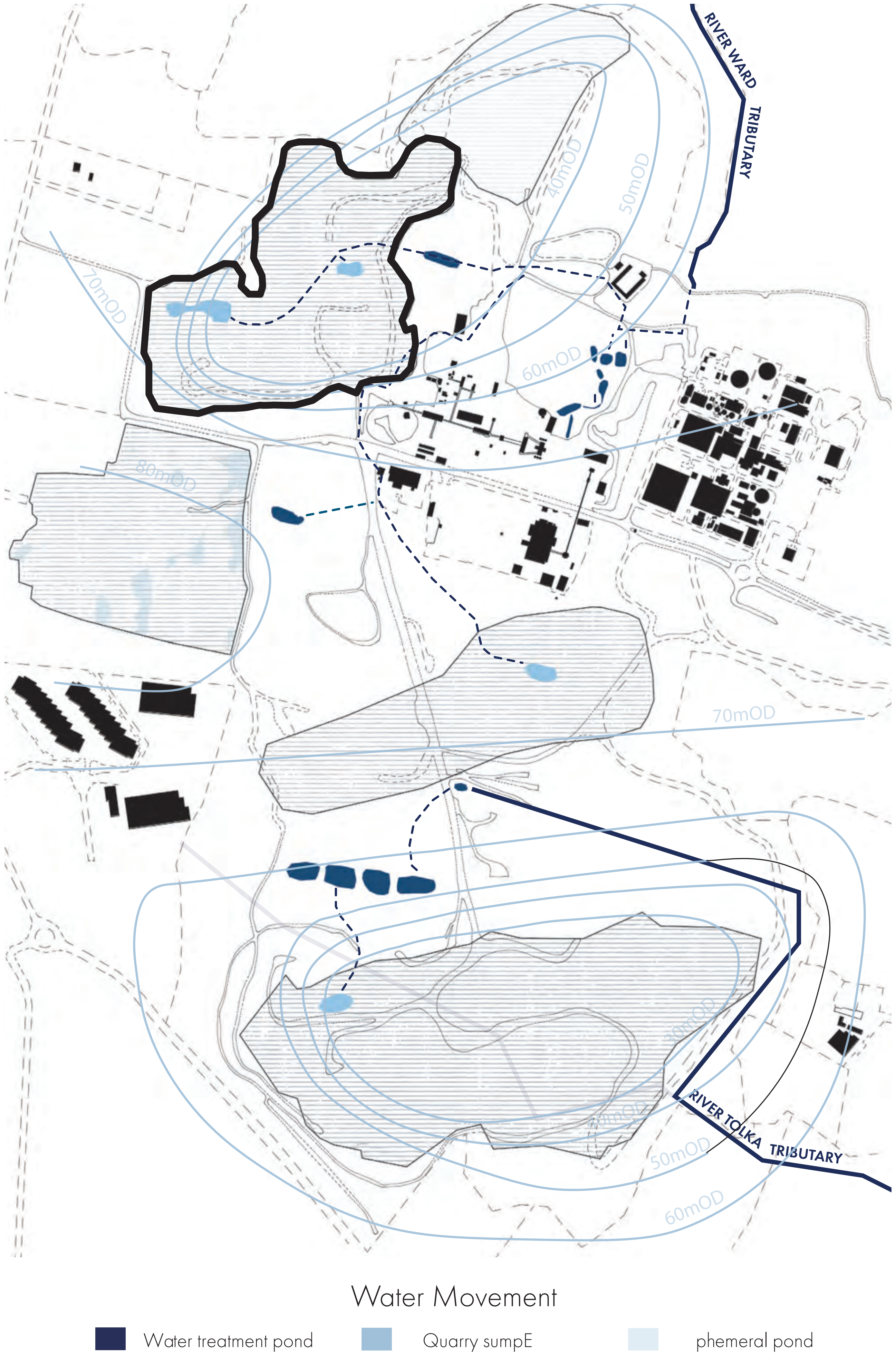


Fig 36; Hunstown Quarry Site Analysis

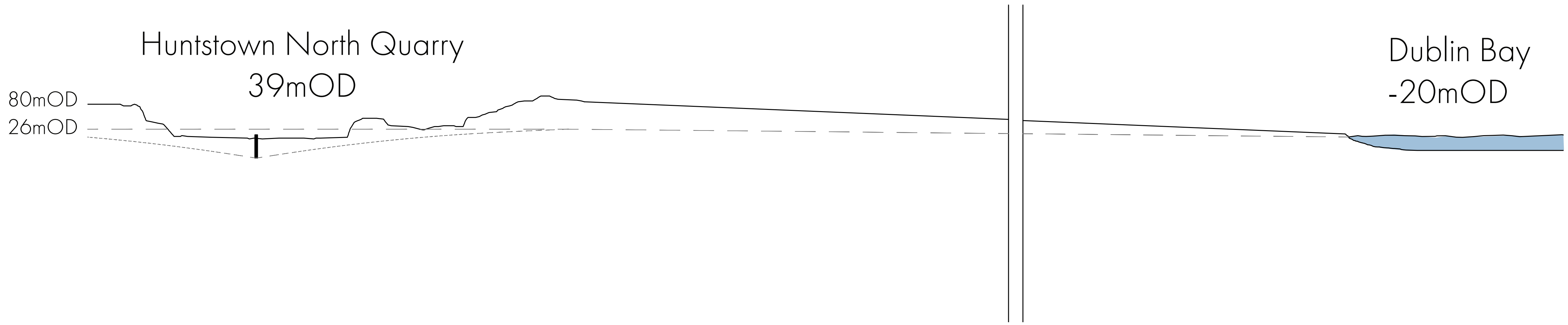


Fig 37; North Quarry Section hightlighting depressed water table

After this analysis, I considered **stability** as I knew I was going to be constructing along the walls of the quarry. I chose to build along the southern edge where the gradient was lower as it was the initial access route for machinery up and down from the quarry floor. This edge also had access to the cross road running through the Huntstown site and as the rock faced south its edge could take advantage of stone's natural ability to store heat in order to maintain a pleasing temperature, cooling the building in summer while heating the building in winter.

Regarding the stability of the rock itself, the quarried bedrock is a carboniferous limestone conglomerate and is part of the Boston Hill formation dating back 355 million years. The exposed rock within the quarry is calcareous mudstone, shale and fossiliferous limestone all of which are quite brittle and unstable. In order to compact this, I introduced rock anchors to any exposed rock face, improving the stability of the quarry walls.

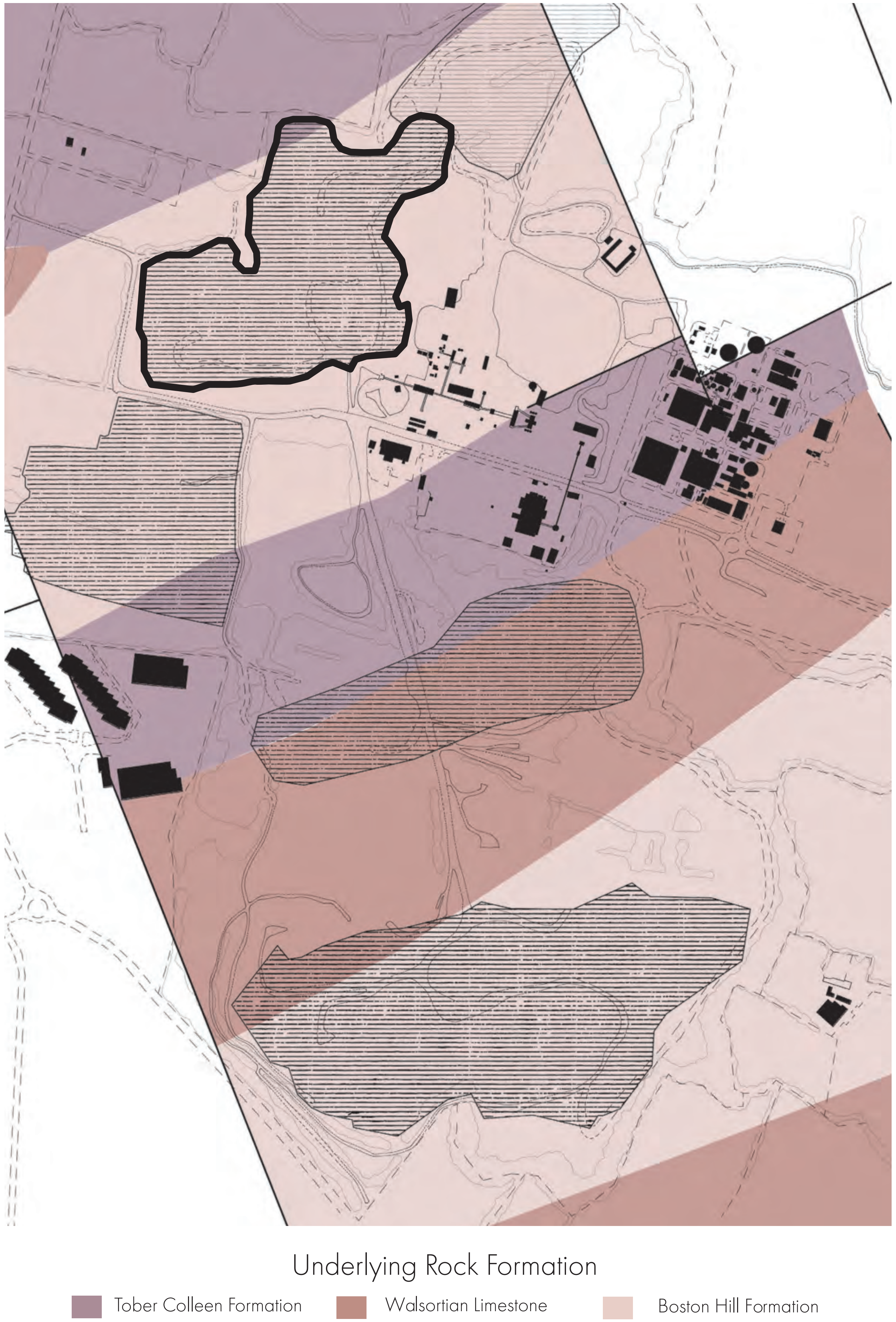


Fig 38; Huntstown Quarry Sitre Analysis


Fig 39; Rock Face of North Quarry (Laka, 2022)

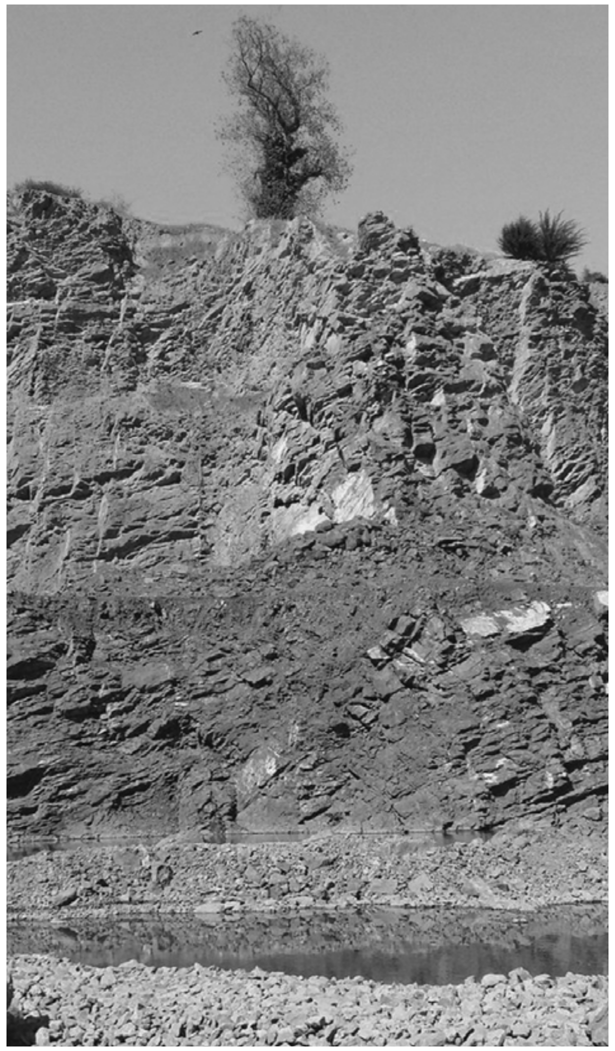


Fig 40; Rock Face of North Quarry (Arts, 2016)


Fig 41; Rock Face of North Quarry (Arts, 2016)

AGE (MILLION YEARS)	ERA	PERIOD
0.00007	CENOZOIC	QUATERNARY
0.01		
1.6		
65		TERTIARY
135	MESOZOIC	CRETACEOUS
205		JURASSIC
250		TRIASSIC
290	UPPER PALAEZOIC	PERMIAN
355		CARBONIFEROUS
410		DEVONIAN
438	LOWER PALAEZOIC	SILURIAN
510		ORDOVICIAN
570		CAMBRIAN
2500	PRECAMBRIAN	PROTEROZONIC
4000		ARCHAEAN

Fig 42; Rock Formation Timeline

HUNTSTOWN

ANTHROPOCENE — Quarry Activity

HOLOCENE — Manmade Soil

PLEISTOCENE — Glacial Till

Deposition & Erosion
(no trace in Huntstown)

Tober Colleen

Waulsortian

Boston Hill

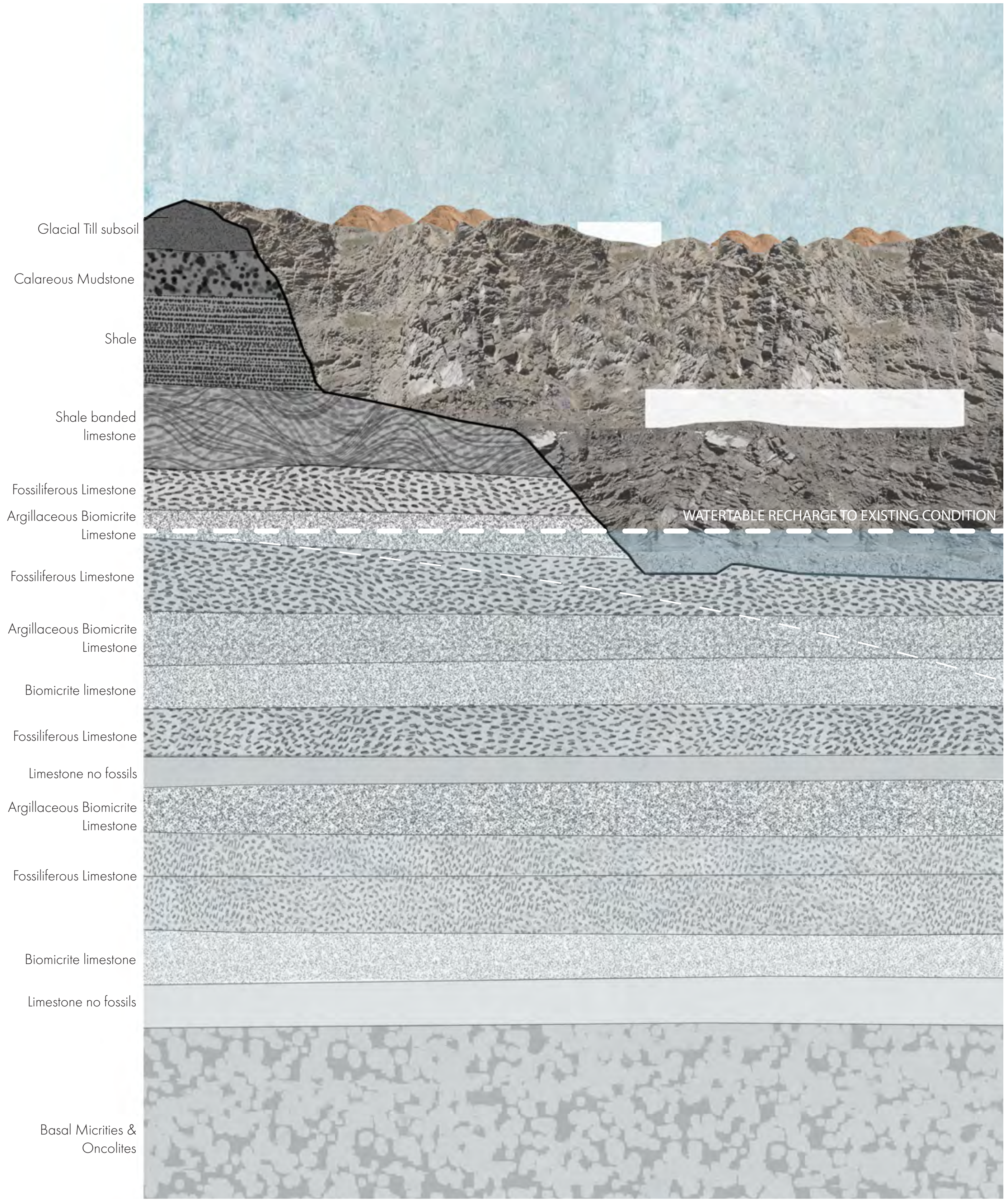


Fig 43; Section through North Quarry, Bostin Hill Formation

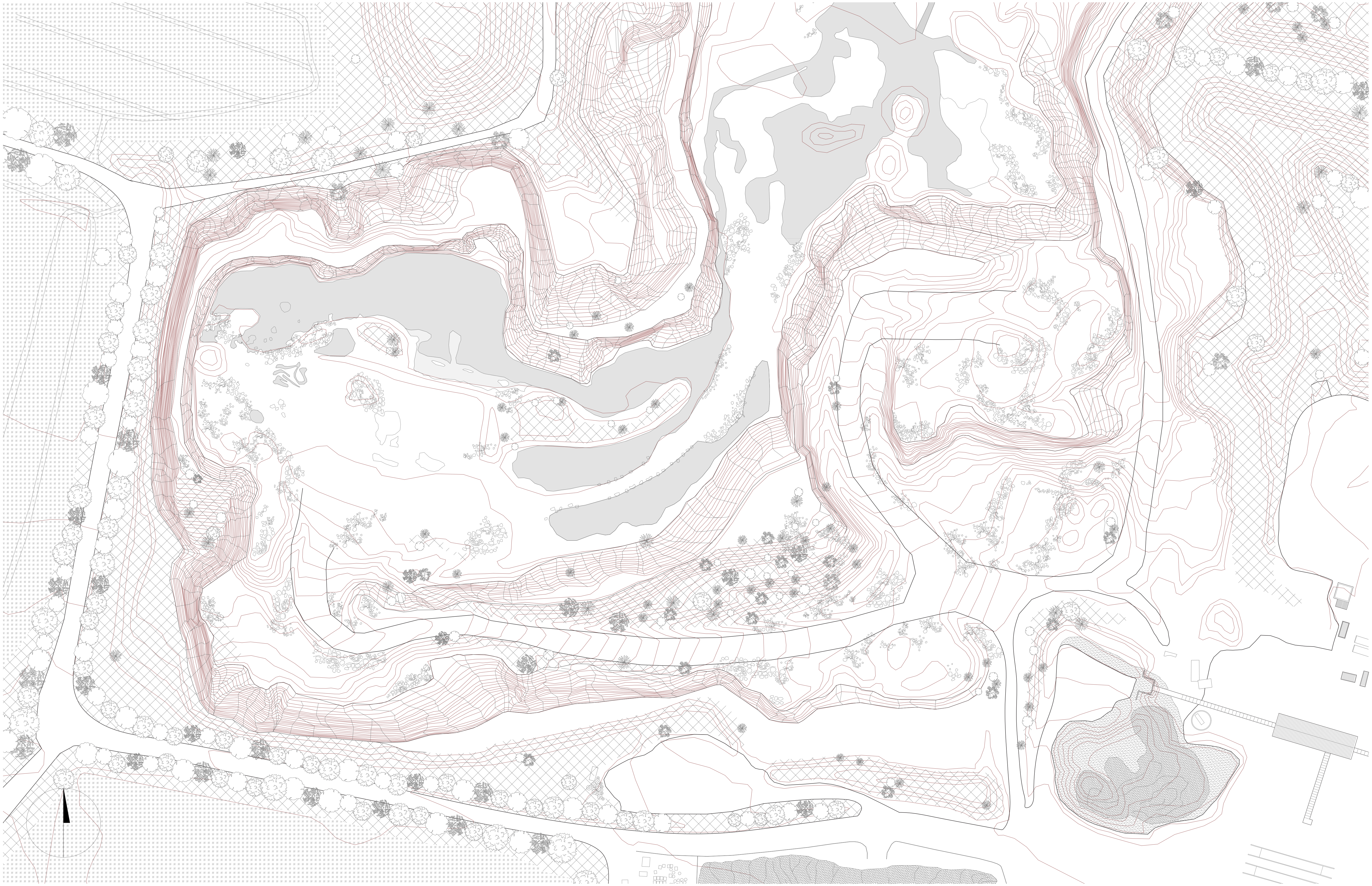


Fig 44; North Quarry Existing Site Plan

THE NEW CONDITION

BRIEF

Following from my exploration of companies in Europe, I developed my own brief suitable to our climate. My goal is to develop a space where an earth building product could be manufactured while also providing spaces where research could be conducted, prototyping could be tested and learning could be shared with the public. The aim would be for earth building to become a trusted standard for widespread use within the Irish built environment. Therefore, my brief is split between manufacture and learning network. The manufacture would be based on the production line of an earth product while the learning network would be based on the educational journey through the building.

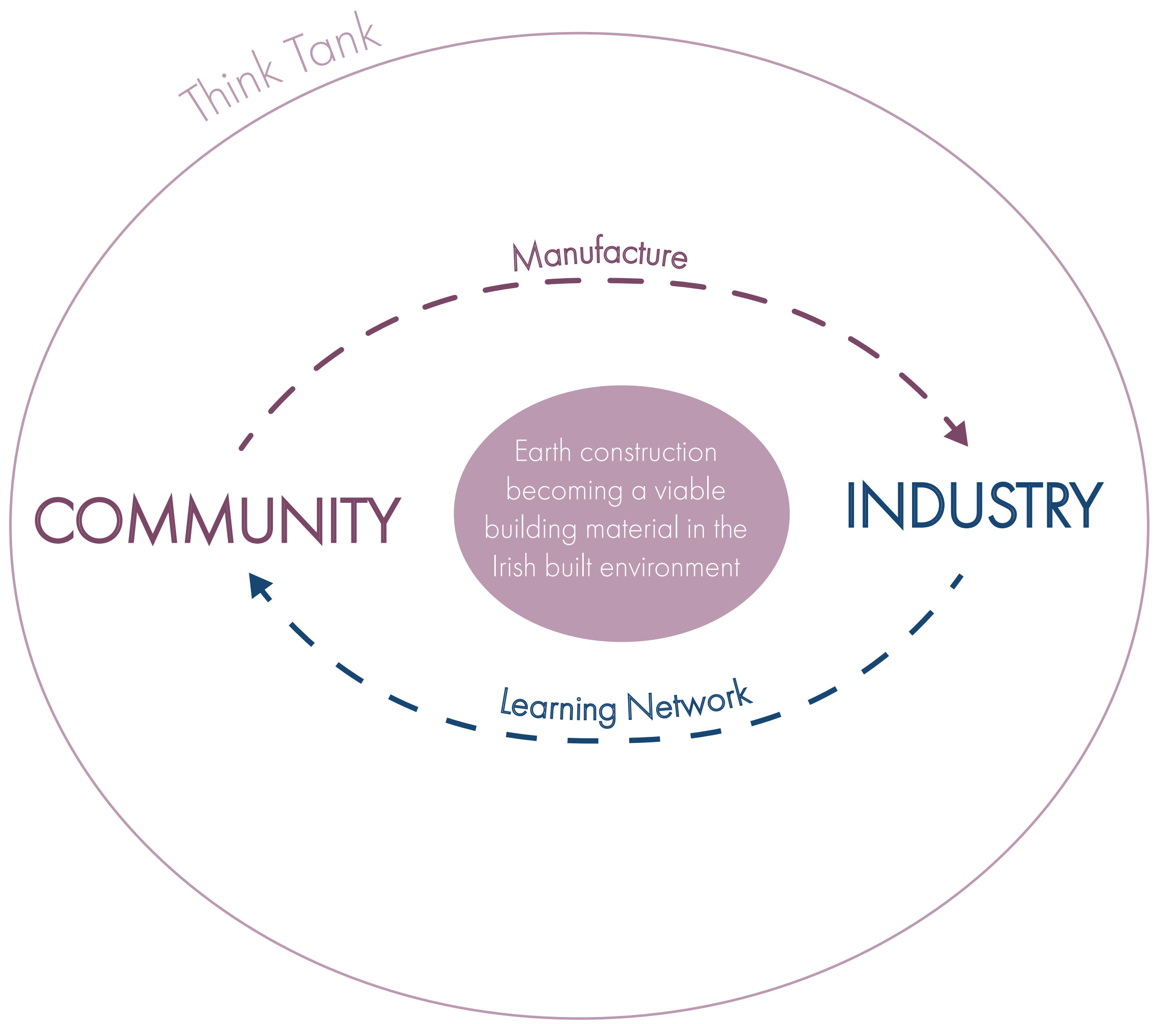


Fig 45; Brief Diagram

I began by investigating different types of earth construction such as compressed earth blocks and rammed earth. I took part in the 'Terra Workshop' conducted within TUD Grangegorman by James Martin and EibhlIn Ni Chathasaigh of Ithirlann where I learned about the differentiating properties of soils and the makeup of different soil recipes for earth construction. I also tested different techniques of mixing, tampering and moulding to achieve an earth product. Within the workshop, we built a segment of a rammed earth wall that stands today in Grangegorman.

Fig 46; Images from 'Terra Workshop'

During my research into different types of earth construction, I discovered an English channel initiative called 'CobBauge'. It is a composite cob wall which is split into two layers made of different types of hemp and subsoil with a particular level of clay content. I feel that this would be an appropriate construction type for Ireland, where the soil is particularly clay rich, and decided to use this as my manufacturing product that would be used within the buildings structure and also manufactured within its walls. However, I do not believe CobBauge is the answer to earth construction becoming a viable construction standard within Ireland. The concept behind my project revolves around research and the progression of materials, constantly looking to improve the product and its qualities in order to push for a zero waste, natural, carbon neutral product that is truly circular in its orgin, from the construction and demolitan waste stream and in its destination, endless reuse without loss of quality and eventually returning to the earths skin itself.

The exterior side being the structural layer made of hemp straw and subsoil with a clay content of 12-20%. This particular type of subsoil should be deep brown in colour and ball in your hands when testing its structure. The clay acts as an adhesive for the other parts of the mixture, therefore, it should be well graded in order to improve its mechanical resistance and reduce its shrinkage. The natural fibres within this layer should be fresh and dry and cut to 15-300mm in length. Its ratio is 1.1 soil and hemp straw creating a dense block.

The internal side being the thermal layer of the wall made of hemp shiv fibres and soil with a clay content of 60% or more. In order to achieve this clay must be added to the excavated sub soil. This subsoil is then mixed with water to achieve a pourable clay slip which adheres the natural fibres together. Its ratio is 1:3 with one part clay slip and three parts hemp shiv fibres in order to achieve a lightweight block with a U-value as low as 0.23. The level of clay added must be tested to improve the lightweight blocks thermal properties as, the higher the clay content, the lower the U-value achieved.

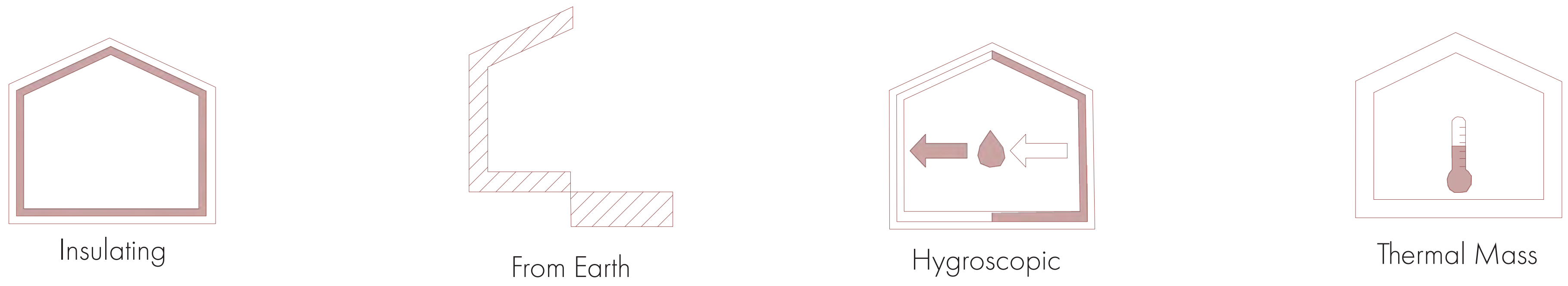


Fig 47; CobBauge Properties Diagrams

Structural Layer

Thermal Layer

Fig 48; Testing of the Cobbauge block process

Plan

Fig 49; Finished CobBauge blocks for exhibition

Elevation

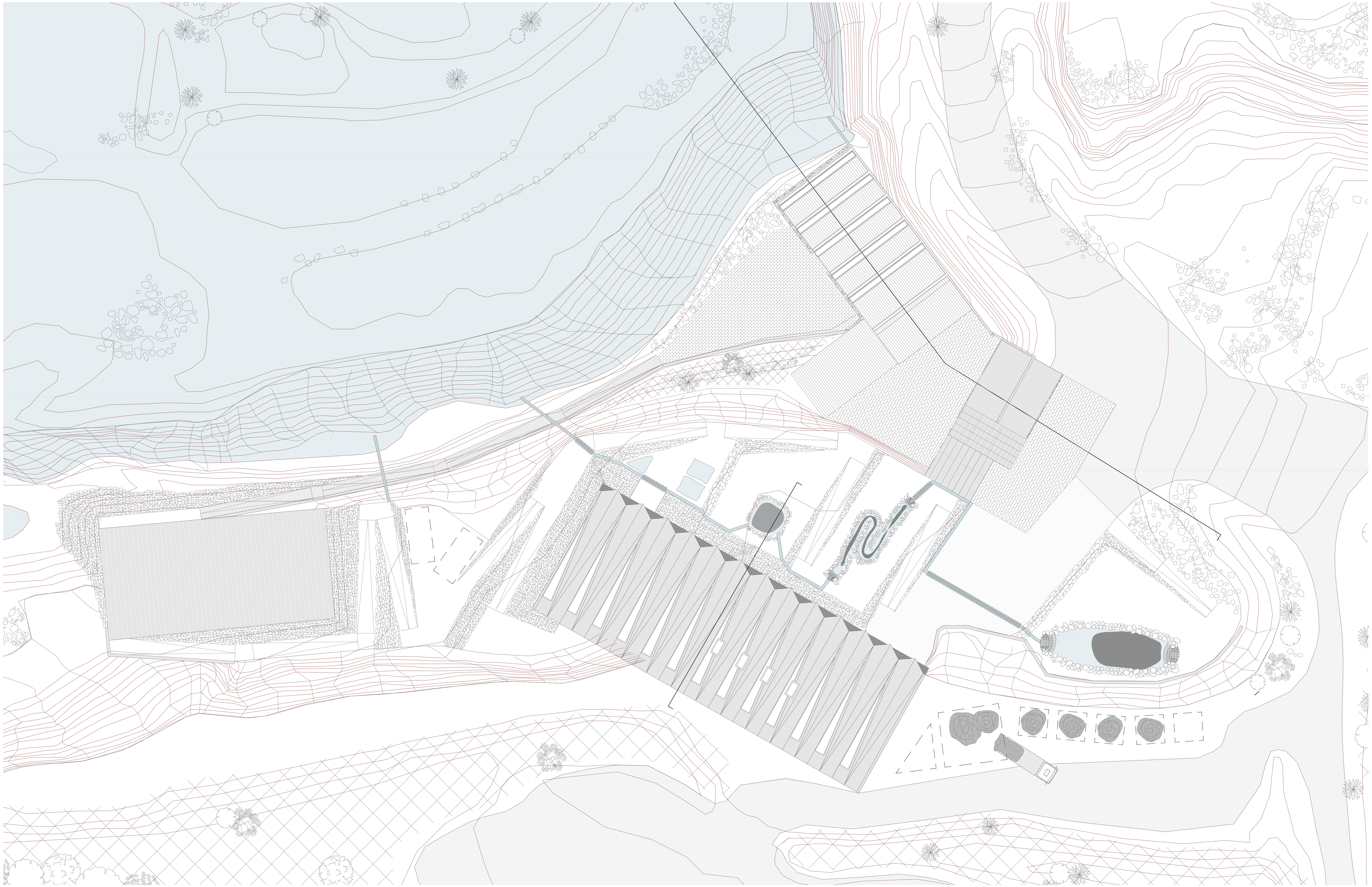


Fig 50; Proposed North Quarry Site Plan

FORM

I began to consider the buildings form on the site after clarifying my brief. I worked with the existing contours on the slope where possible, and tested different positionings using a physical model of the southern elevation of the North Quarry. Given the size of the testing site, it was difficult to find its form and exact location. As an alternative, I took the approach that the form would be based of the movement on site.

1. The moment of soil

2. The movement of water

3. The movement of visitors

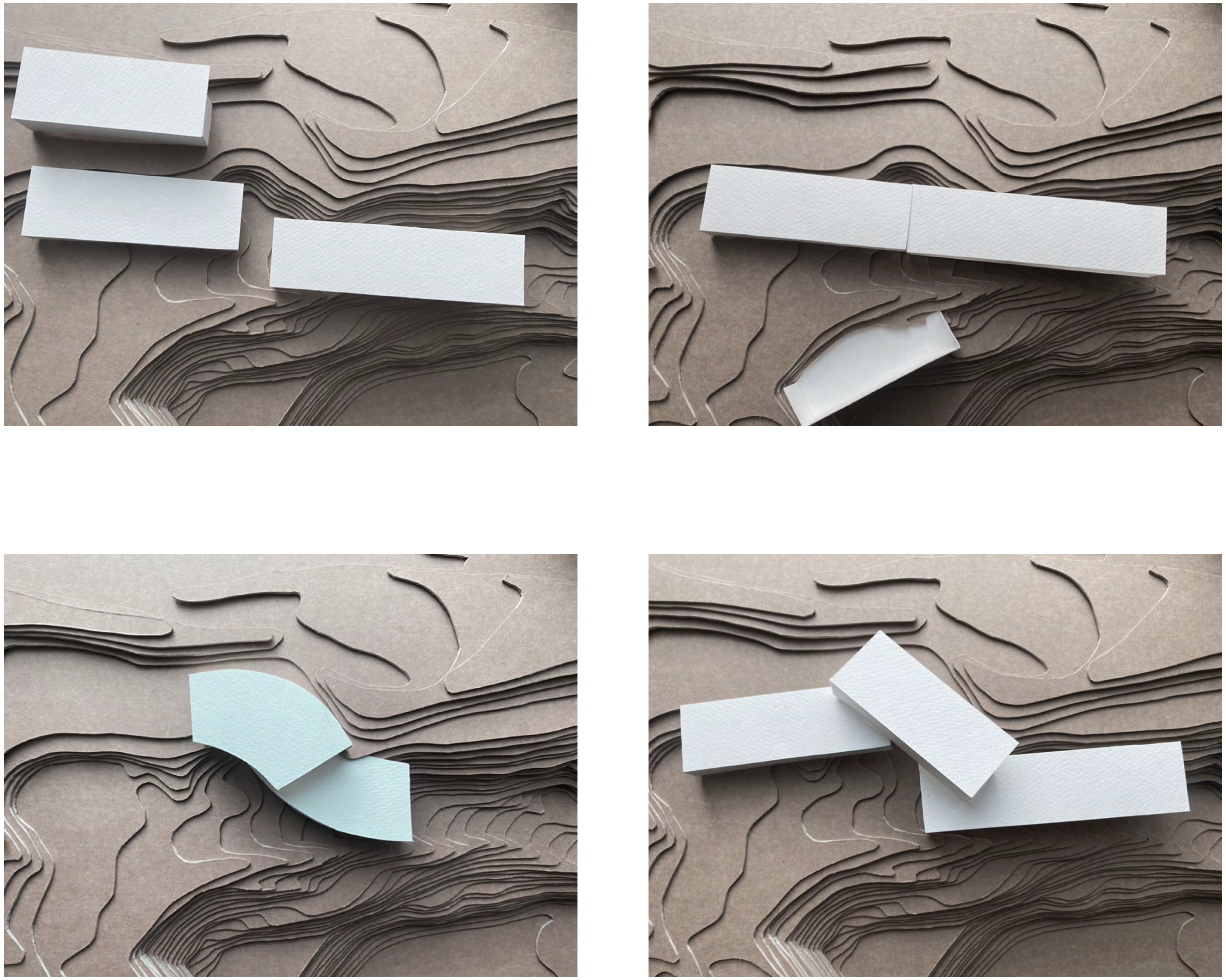


Fig 51; Testing different forms on site

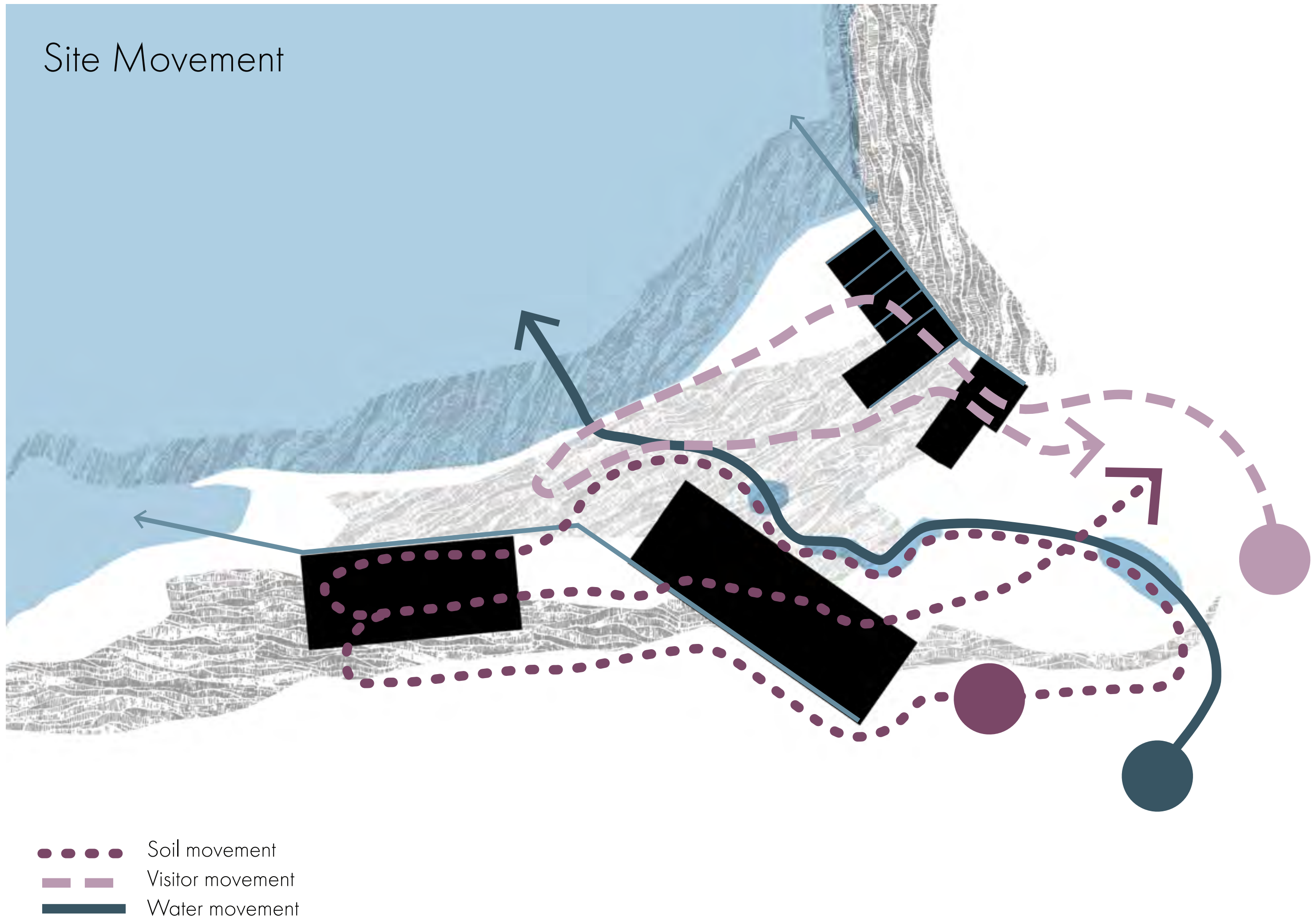


Fig 52; Movement Diagram

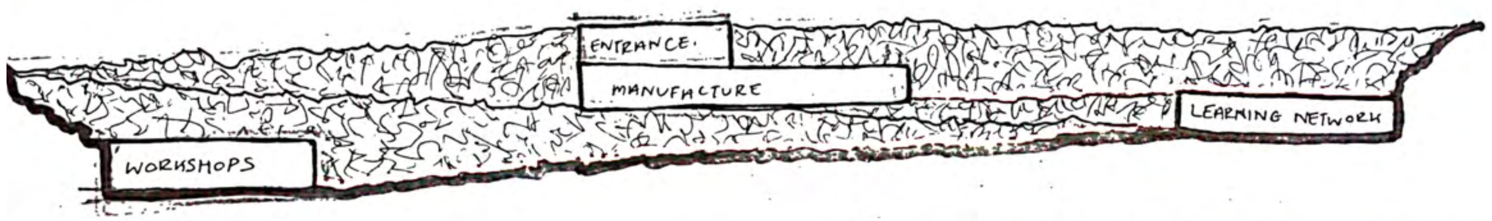


Fig 53; Site Sketches

Fig 54; Stage 4 Model for Presenatation

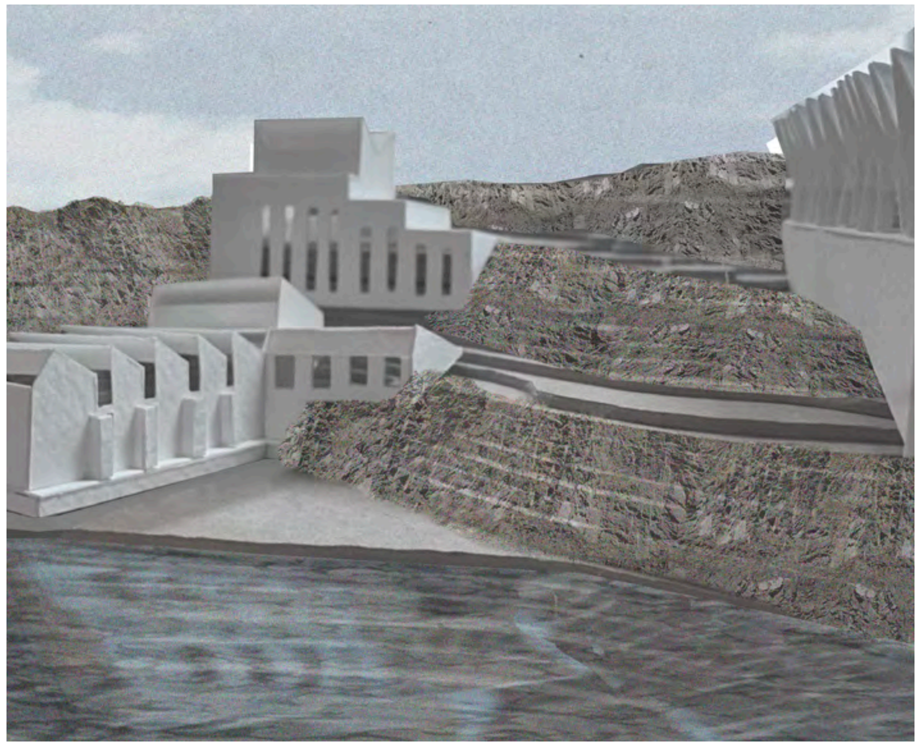


Fig 55; View from waterfront at bottom of site

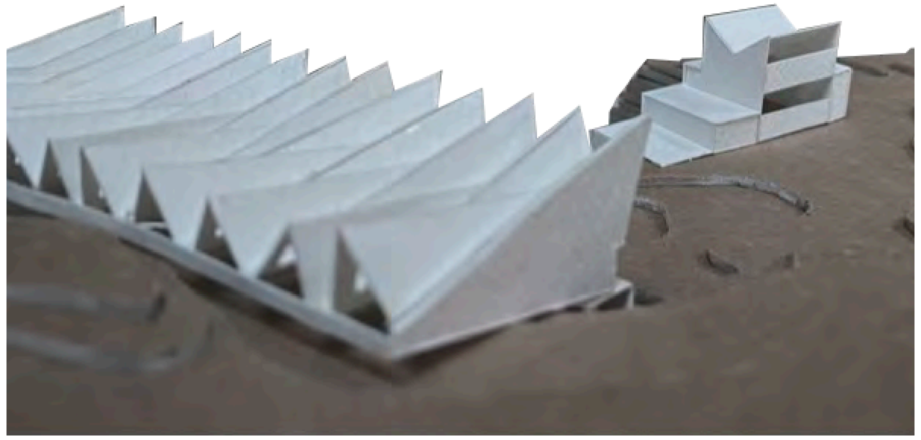


Fig 56; View from top of site

The **movement of soil** became centred around the production line of a CobBauge block:

1. The soil arrives on site, it is tested for its clay content. Soul that contains an adequate clay content is moved to storage. Soil that contains too high or too low a clay content is decanted into its separate components.

2. The soil is then moved through a sedimentation trap. This removes sand from the soil makeup as the sand settles at the base of the pond within five minutes once the soil has been dumped into the water. Shortly after, water can be drained from the pond leaving only the settled sand behind to be transported to storage for drying.

3. The water is then moved through a sedimentary basin in order to separate the silt from the clay mixture. This process takes approximately three hours and once the water is extracted, the silt left behind can be transported to storage for drying.

4. The water is then moved through a filtration pond in order to sieve the remaining clay from the water. This clay can then transported to storage for drying

5. Within the storage units, hemp shiv fibres and straw fibres are stored along with any of the moving machinery.

6. The separated elements are stored separately with both an inlet and output point to allow for a drying period.

7. Soil of adequate clay content is stored on site, this soil is the most used for testing therefore is stored close to both of the access routes to the manufacture building and learning network building.

8. The soil then begins to move back up the site as it is brought to the physical mixing area where it is separated into mixtures for the structural and thermal layers of the block. To achieve the correct ratio, the separated components are added when needed to these mixtures.

9. From here, both mixtures are moved inside the manufacture building and tested to make sure they have the correct ratios, with special care taken to its clay content. This testing is done within a laboratory.

10. For the structural layer, the soil mixture is mixed with hemp straw fibres and water to achieve its desired consistency.

11. For the thermal layer, the soil must then be soaked in a clay slip for three days in order for the clay particles to dissolve.

12. The clay slip is then mixed with water.

13. It is then sieved to remove any remaining aggregate.

14. The clay slip is then mixed with hemp shiv fibres. 15. Both mixtures are then added to formwork and left to set.

15. Both mixtures are then added to formwork and left to set.

16. Blocks are then transported to the drying area where they will sit for three weeks in order to reach full structural and thermal capacity.

17. The blocks are then moved to holding for transport from the site.

18. The blocks are collected ready to be used as infill within surrounding construction sites.

The **movement of water** on the site is within the soil separation process. It runs down the middle of the site helping to split the manufacture and learning network but also keeping a level of interaction between them. The water for the ponds would be sourced from existing groundwater tanks with the cement plant adjacent to the North Quarry and end within the body of water within the quarry itself.

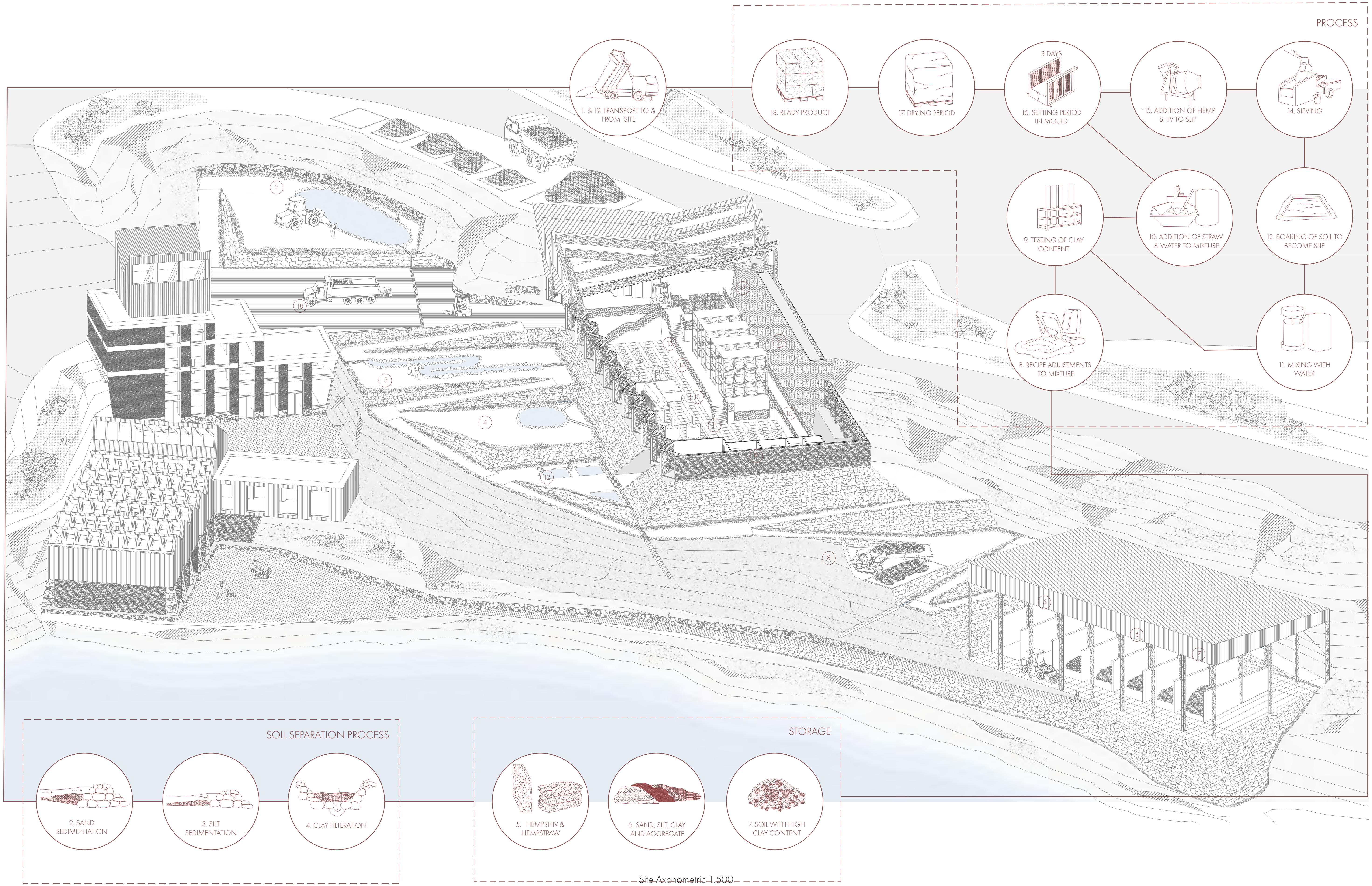


Fig 57; Site Axonometric highlighting Production line

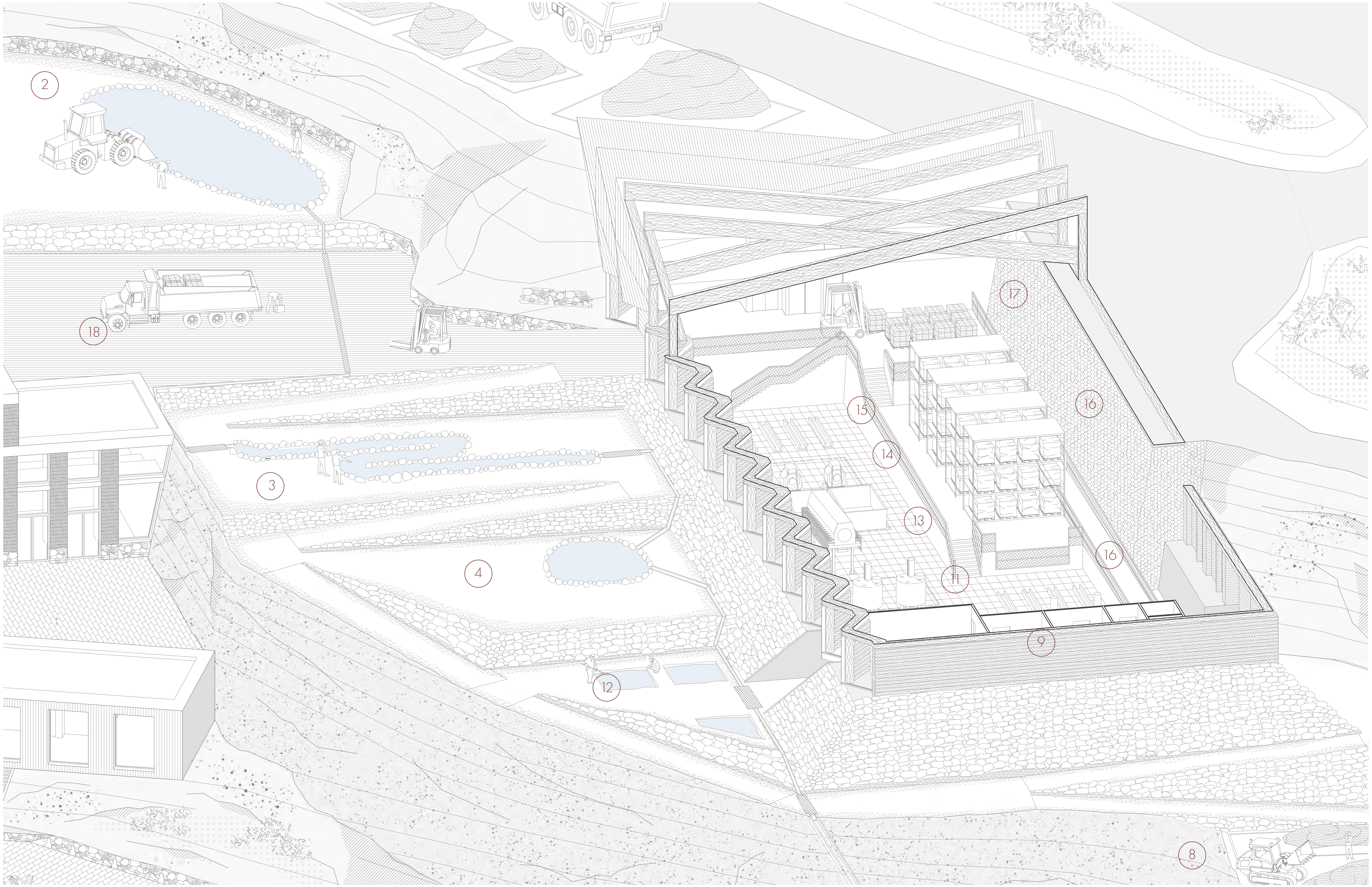


Fig 58; Site Axonometric highlighting Production line 1.200

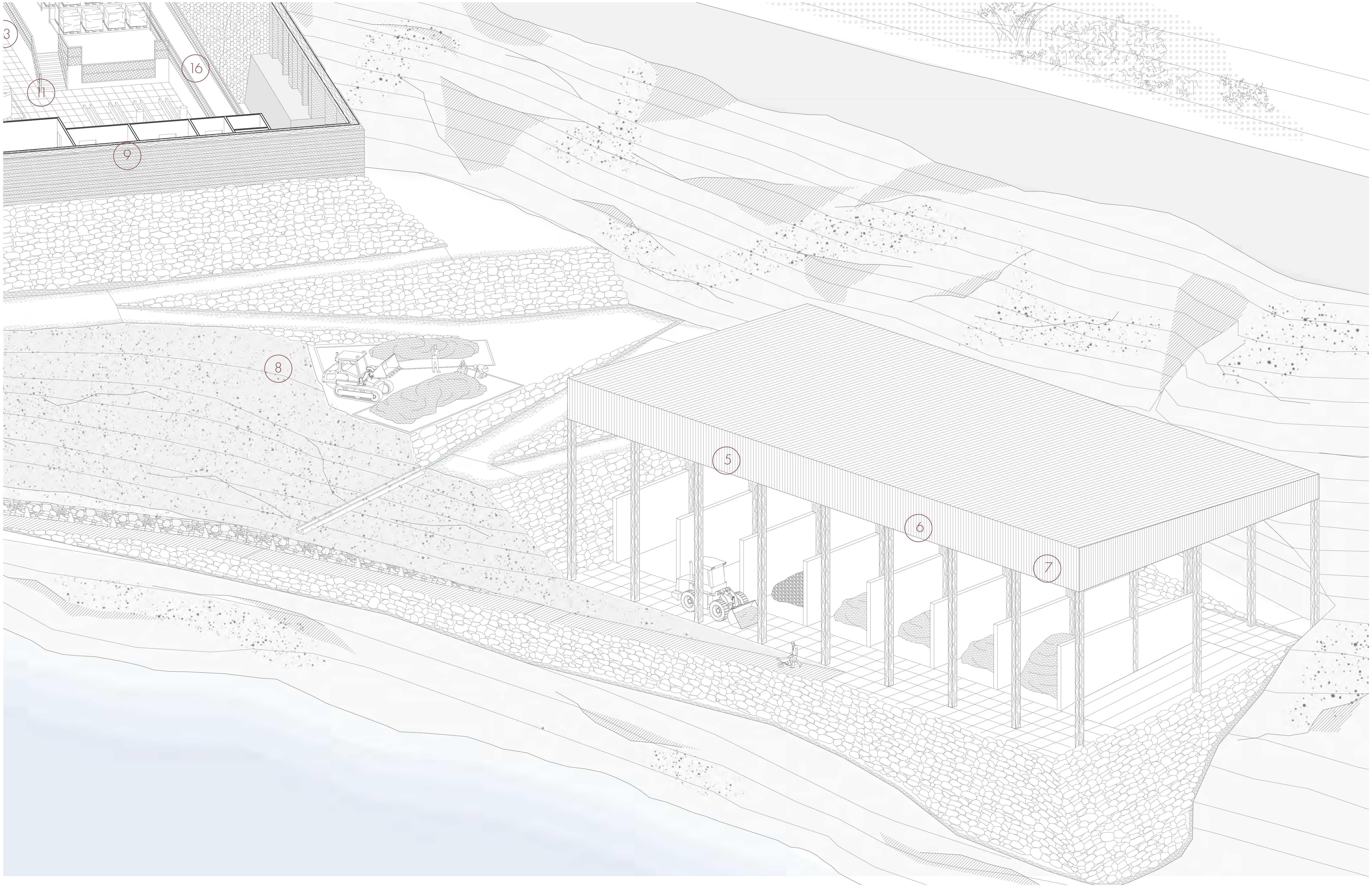


Fig 59; Site Axonometric highlighting Production line1.200

Fig 60; Render from bottom looking towards Manufacture building

The learning network buildings would be based on the **movement of its visitors**. They would be brought on a journey of learning through the site. The building consists of a sequence of spaces that step down the slope from the entrance foyer, to the seminar room, and then to the exhibition space which would open out onto the quarry creating a level of interaction with its content. They would then be guided back inside to discussion rooms to share ideas and an open communal space where workshops could be hosted. This workshop space opens out to an external workshop space that sits along the waters edge. On the top level of the building, I designed a canteen space where the public, existing quarry workers and the new manufacture workers could gather and interact.

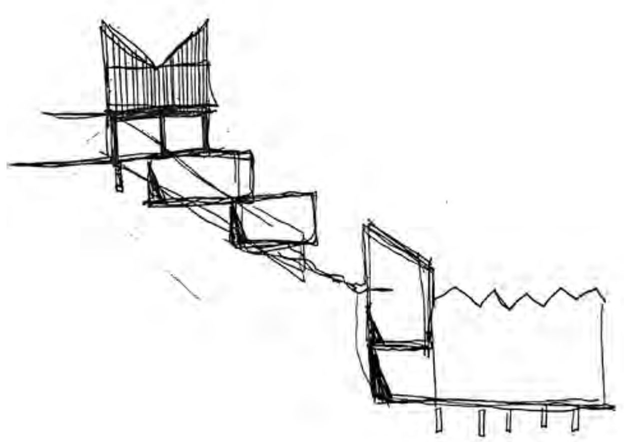


Fig 60; Sketch Section of Learning Network buidling

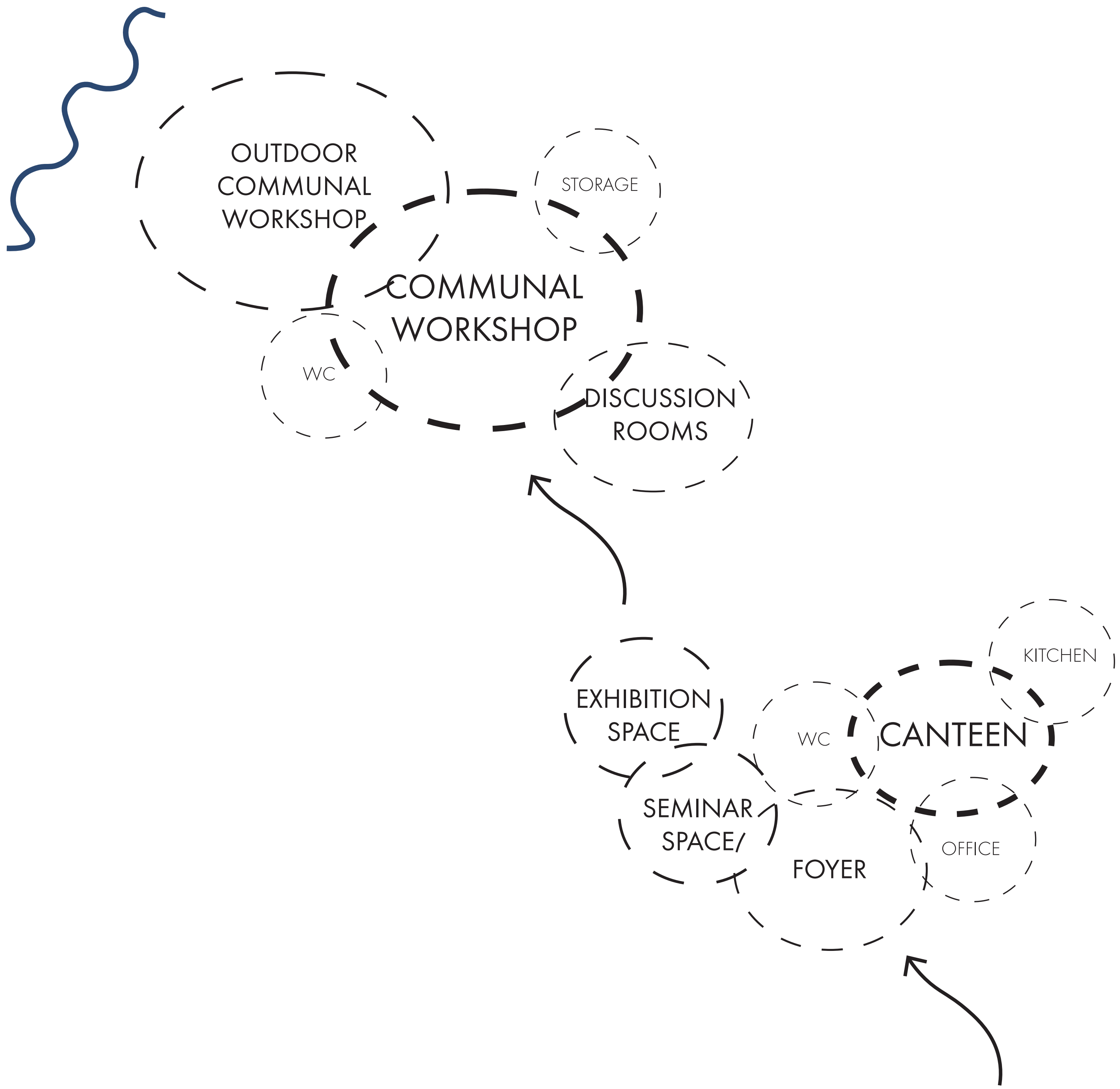


Fig 61; Learning Network Brief Diagram

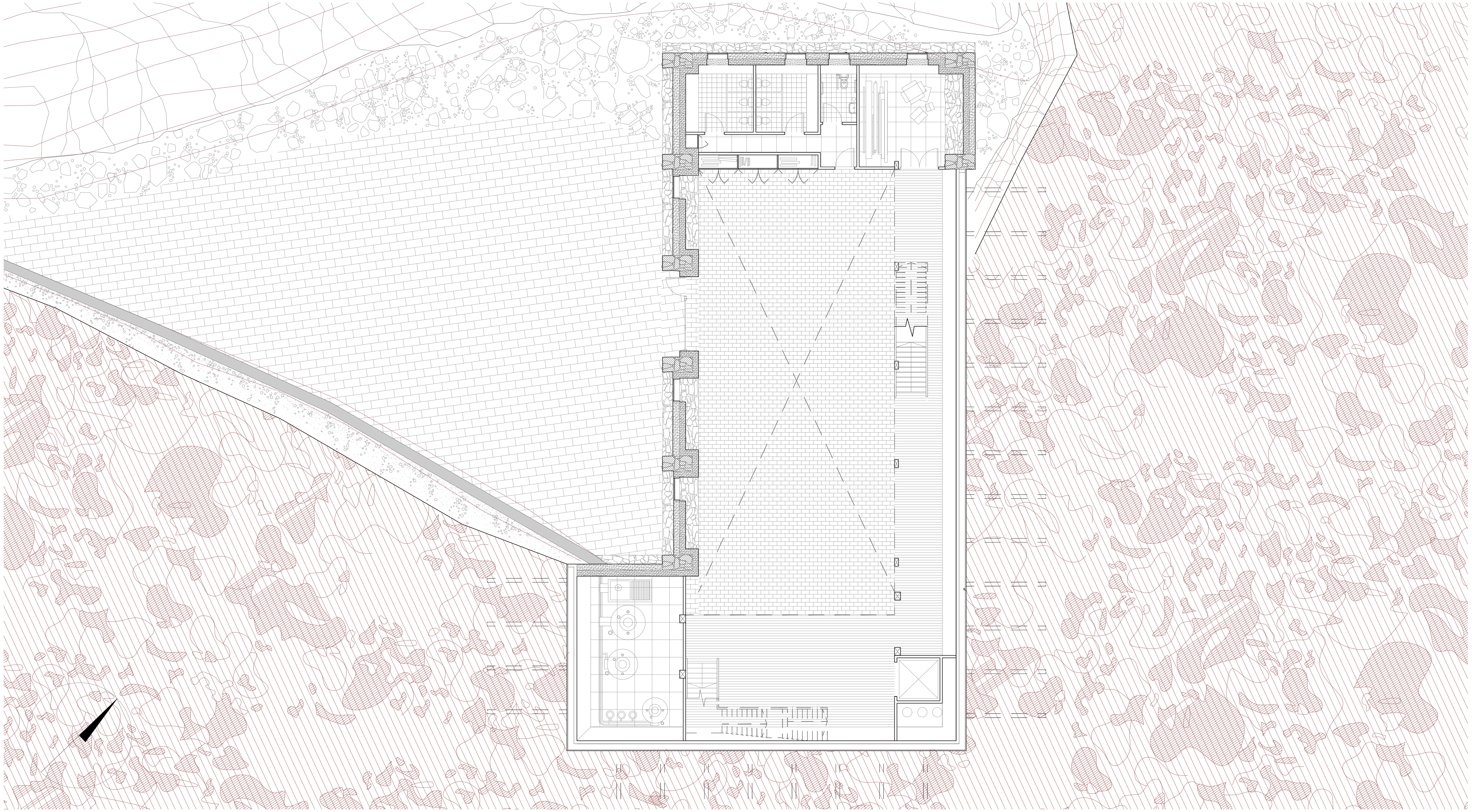


Fig 62; Learning Network Ground Floor Plan 1.200

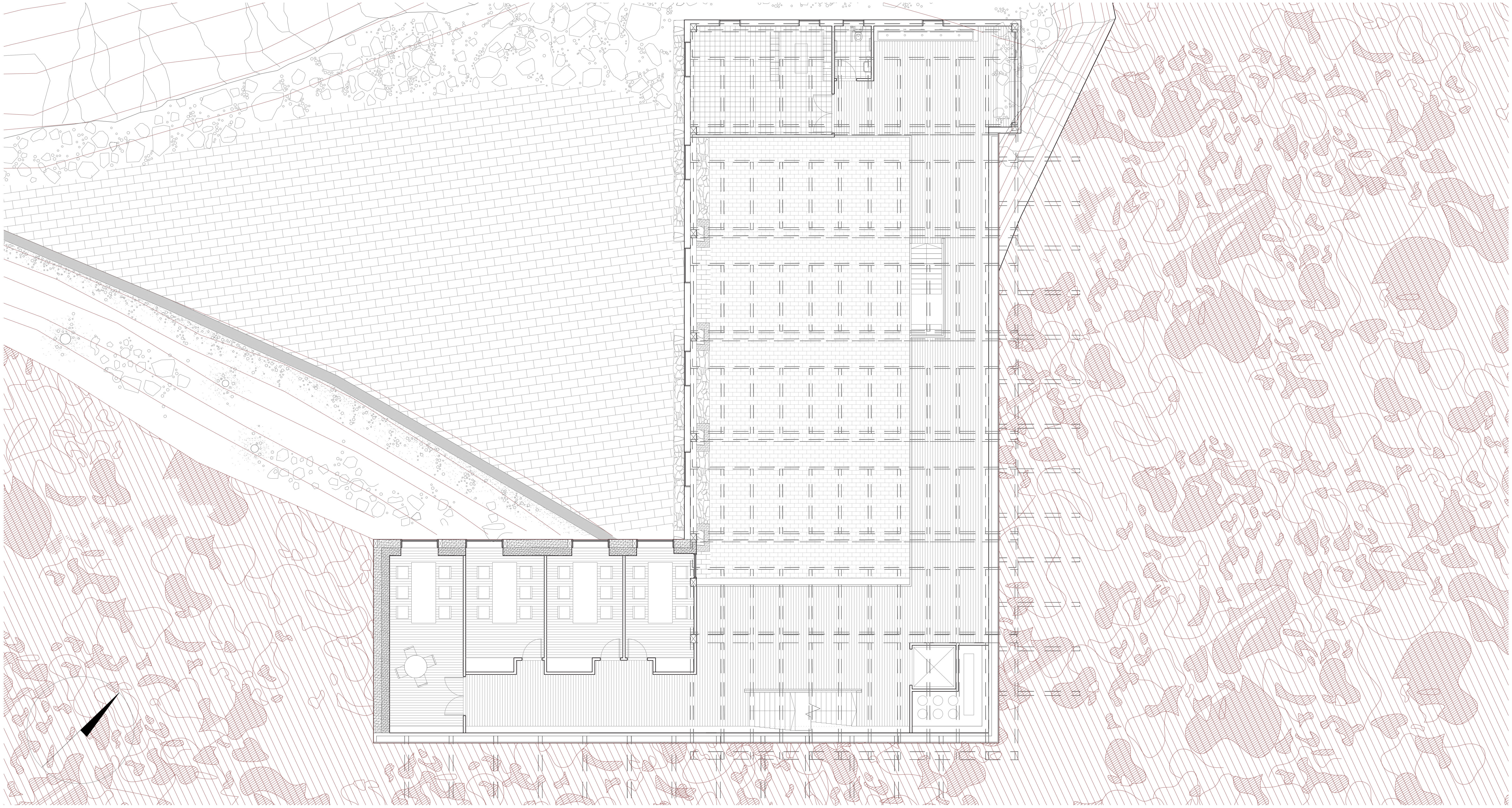


Fig 63; Learning Network First Floor Plan 1.200

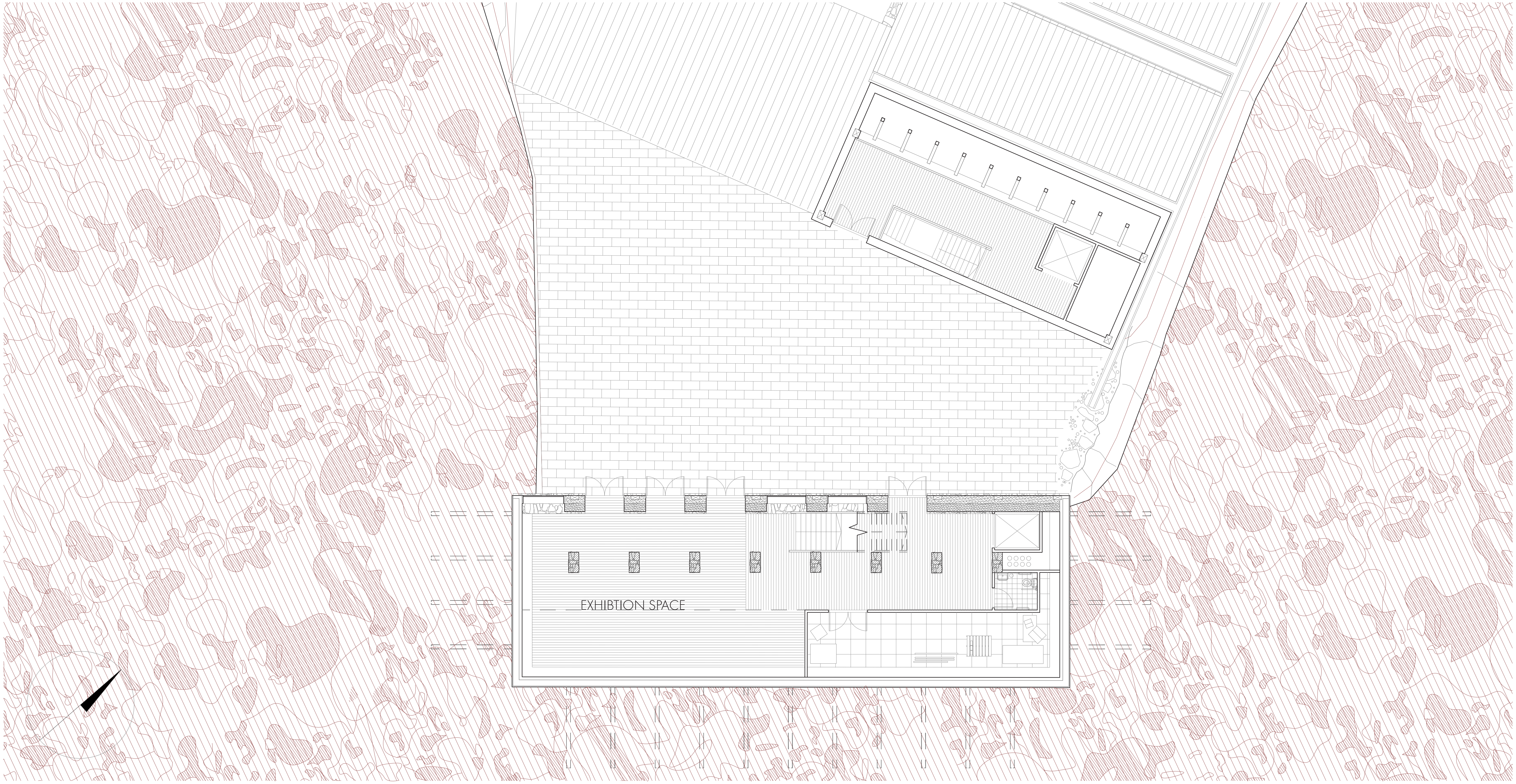


Fig 64; Learning Network Ground Floor Plan 1.200

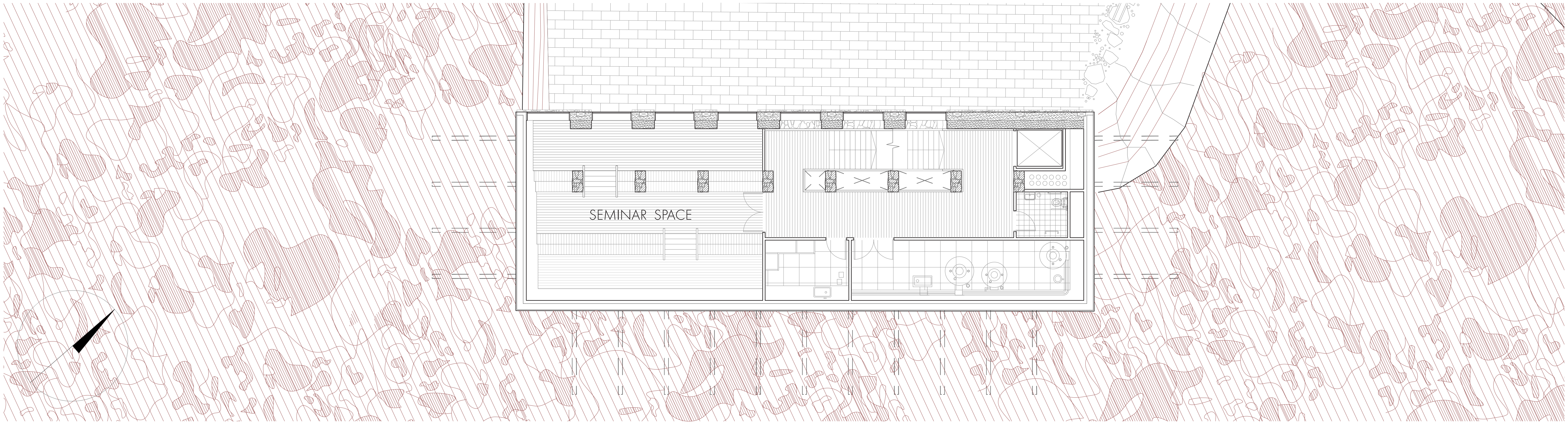


Fig 65; Learning Network First Floor Plan 1.200

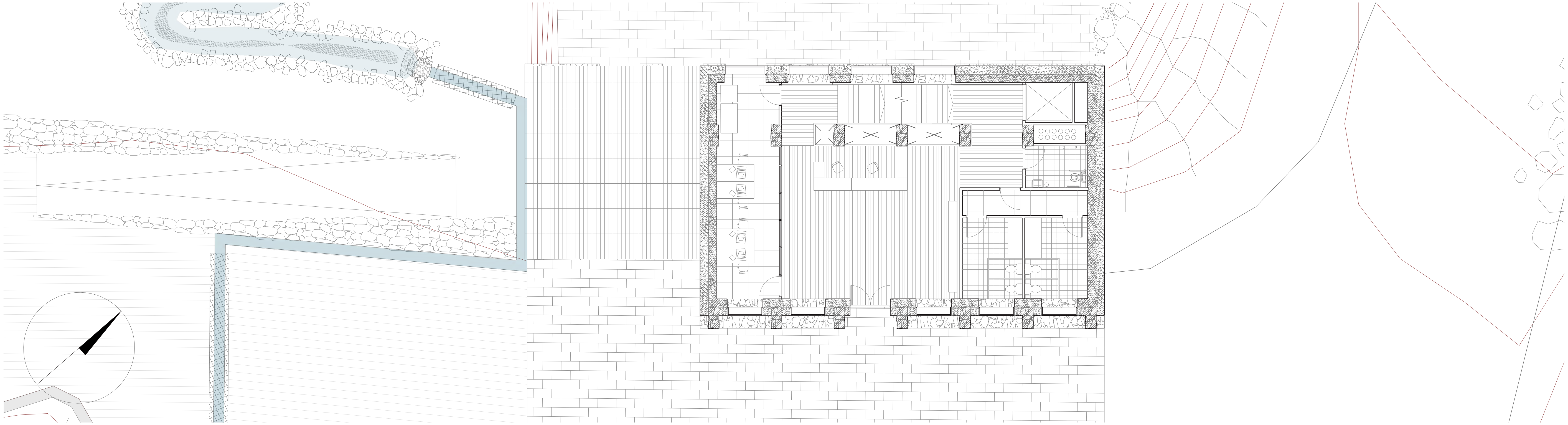


Fig 66; Learning Network Second Floor Plan 1.200

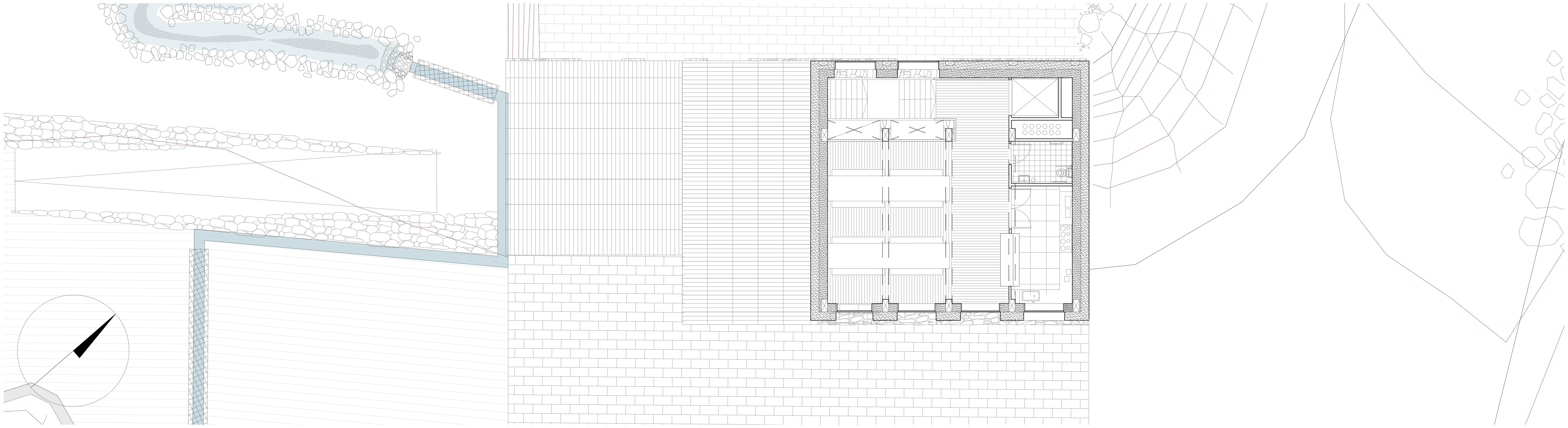


Fig 67; Learning Network Third Floor Plan 1.200

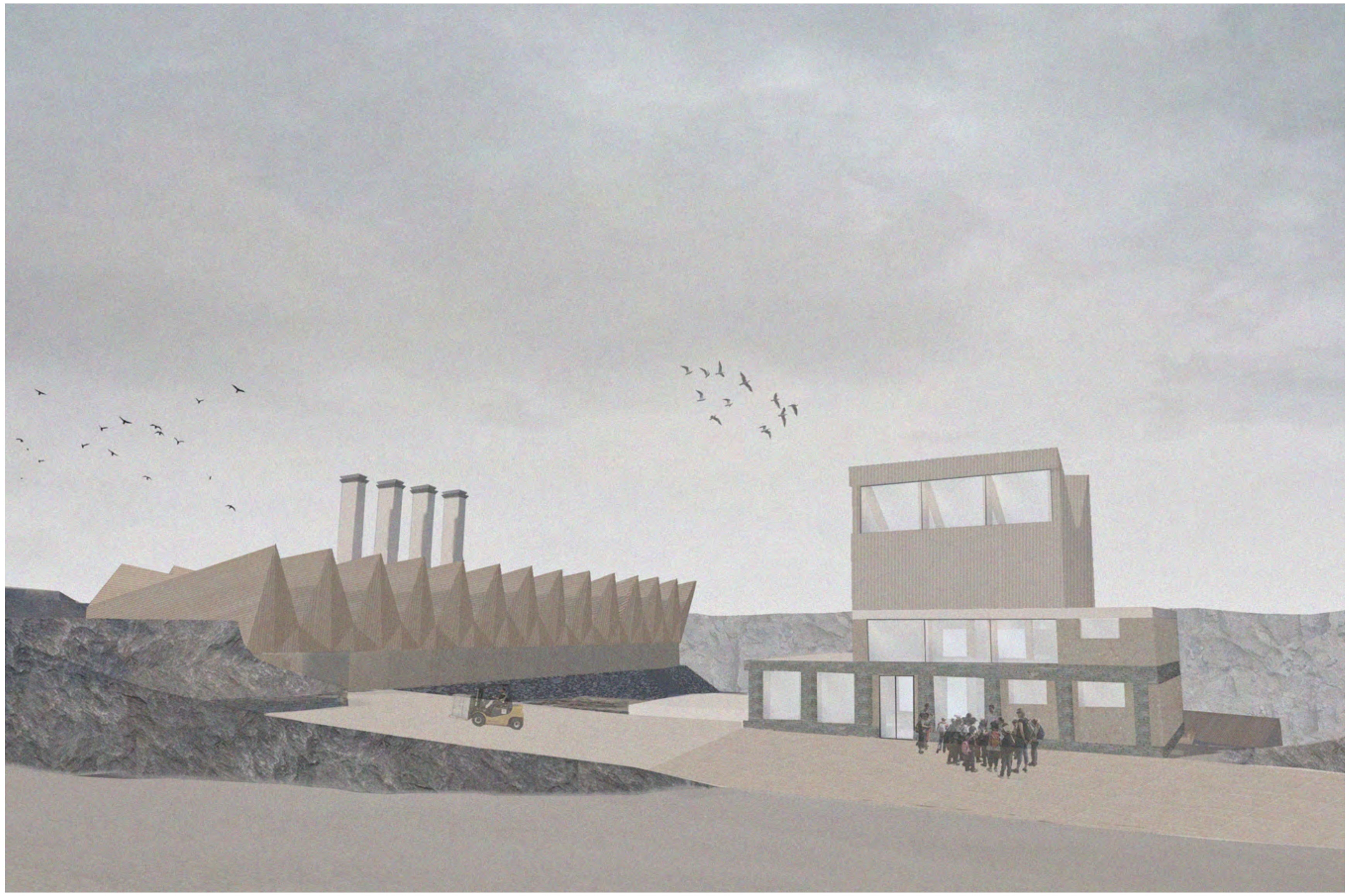


Fig 68; Render of Learning Network & Manufacture building entrance

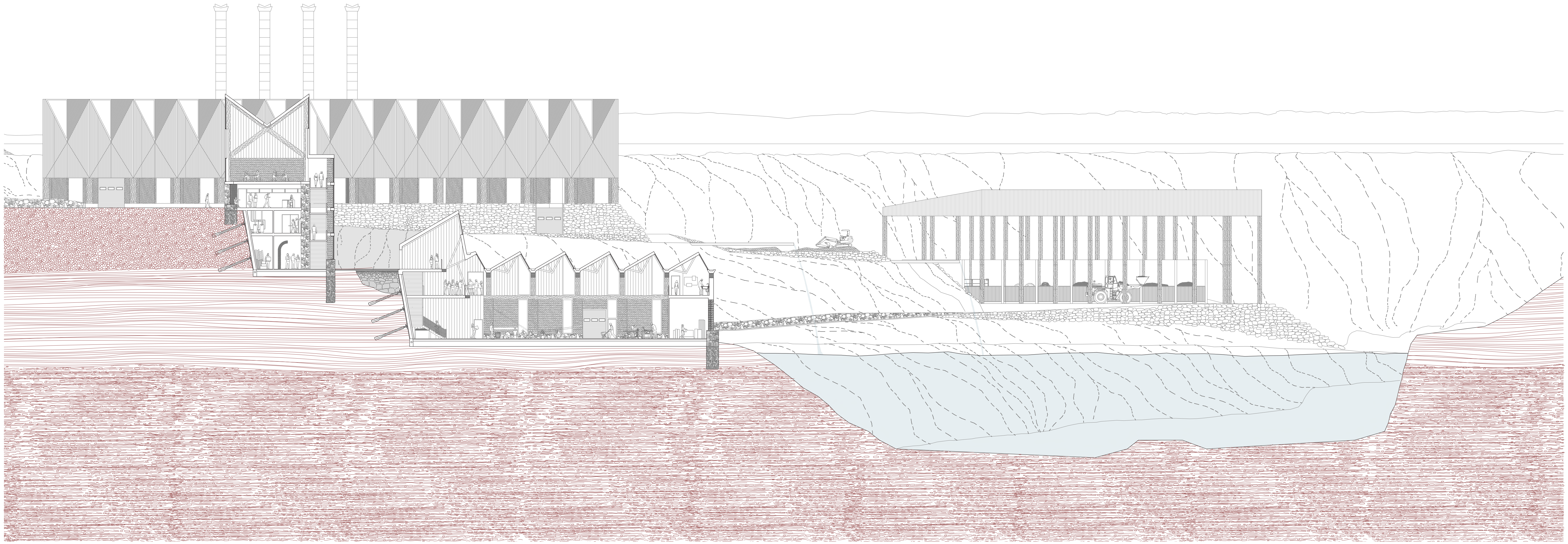


Fig 69; Site Section through Learning Network Building

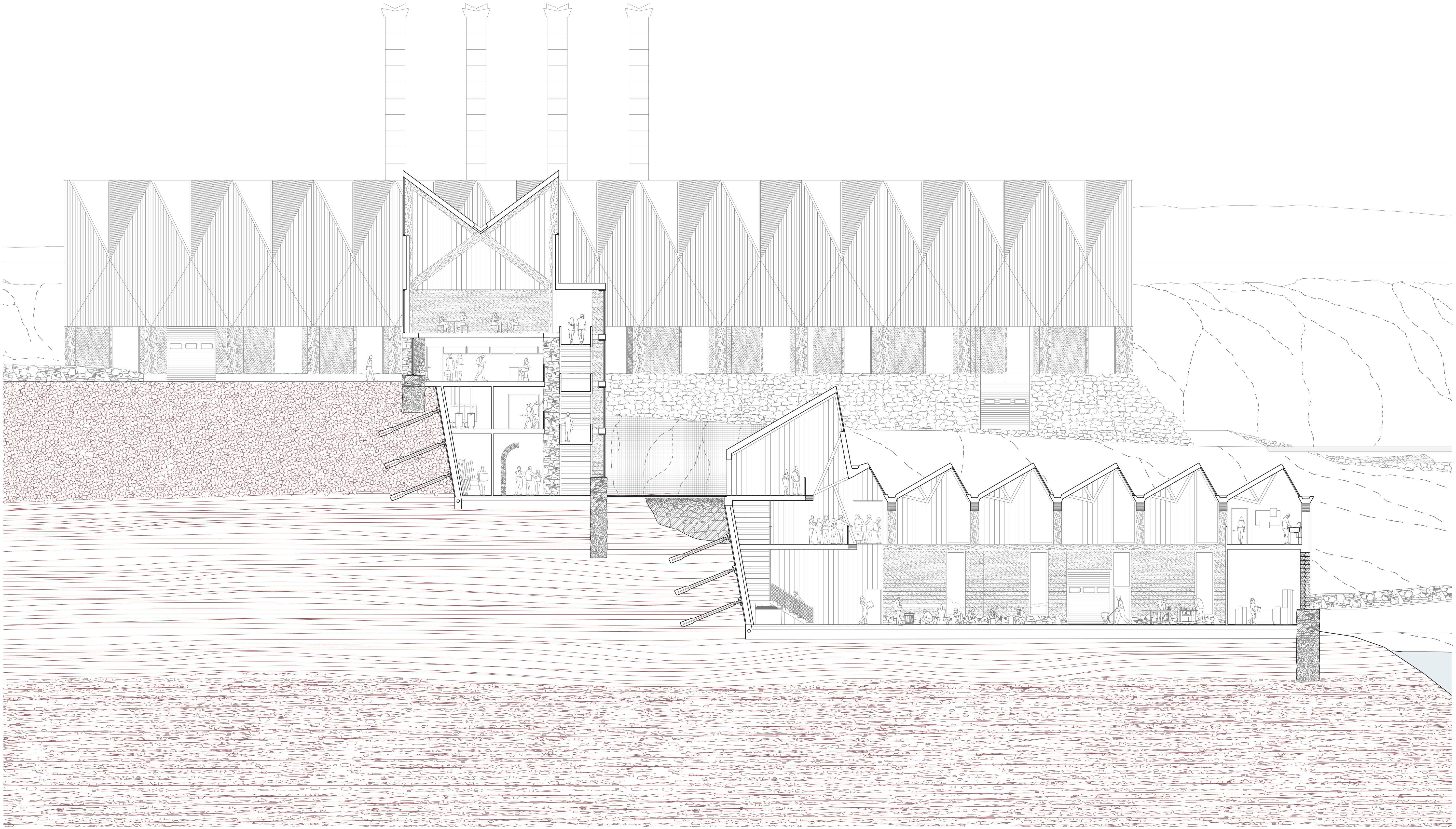


Fig 70; Site Section through Learning Network Building 1.200

STRUCTURE

I set myself construction principles such as the use of natural materials from regenerative resources that would in time be able to return to the earth. I wanted to keep my structure as simple as possible so I decided to separate the different structural elements. This helped to create a hierarchy of materials that in turn helped drive the building's form. For this I split it into stereotonic, infill and tectonic. The tectonic being the lightweight glulam timber roofs in order to achieve the large spans needed within the manufacture and workshop spaces. The Infill being the CobBauge in block, cutting out all other infill materials, such as, foam insulation which would ultimately end up in landfill. The stereotonic being the quarry masonry and groundworks.

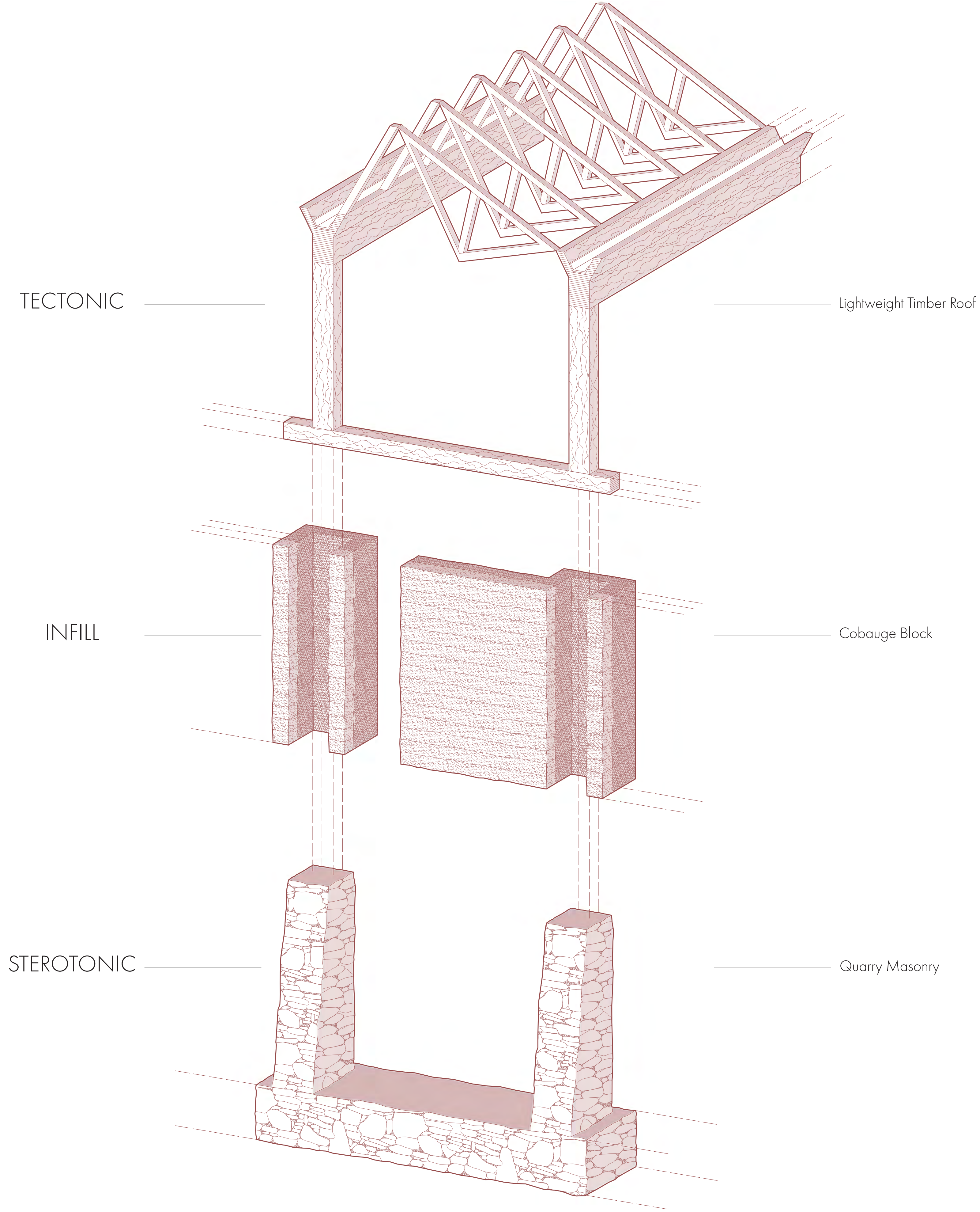


Fig 71; Structural Isometric Drawing

Fig 72; Render of Communal workshop

I took inspiration from Frank Lloyd Wright's Taliesin West workshop where they derived their material from the desert itself. They used stones from the site as aggregate and sand from the surrounding desert within the making of the cement to create a 'desert masonry' forming the base of the building. This raises the question whether something similar could be done within the quarry using stones found on site and limestone calcined clay cement to form the serotonin base of my buildings.

When beginning my design, my initial thinking was that I did not want to disrupt the landscape of the site anymore then was already done. However, upon a deeper analysis of the quarry, I realised it was not a set landscape. The contours are always in flux and would be subject to easy manipulation in order to help work with the site's existing slope. Based on this conclusion, I developed a series of platforms running down the site, each with a different function and accommodating a one metre drop. Ramps run between each platform in order to allow for the flow of material by digger up and down the site. The platforms allow for a nine meter drop over the course of the site down to the material storage space. This material storage space sits four meters above the communal workshop to allow for a flow of material between both manufacture and learning spaces.

Fig 73; 'Desert Masonry', Taliesin West Building
(Frank Lloyd Wright, 2019)

Fig 74; 'Desert Masonry', Taliesin West Building
(Frank Lloyd Wright, 2019)

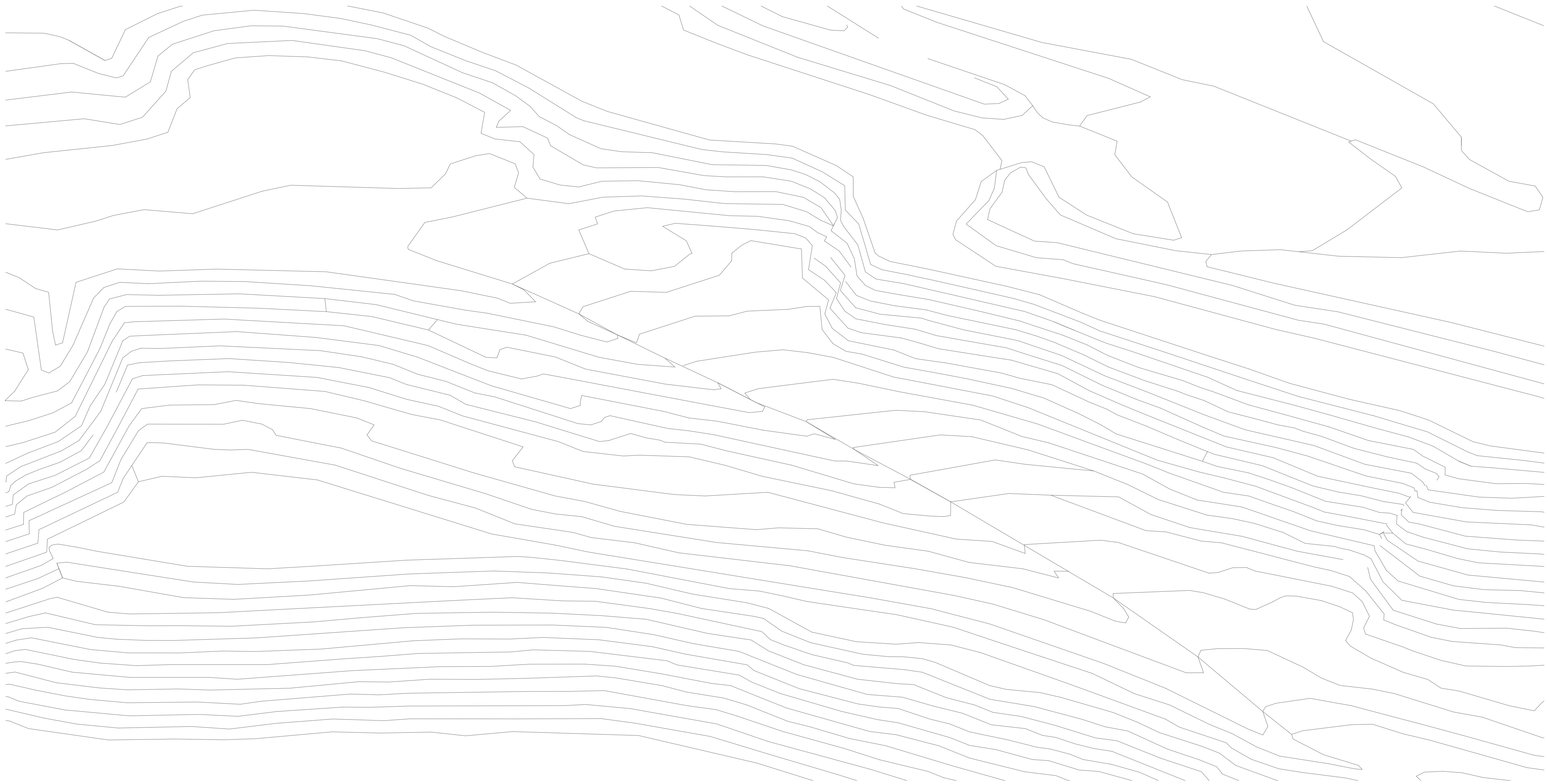


Fig 75; Existing Site Condition Axonometric 1.1500

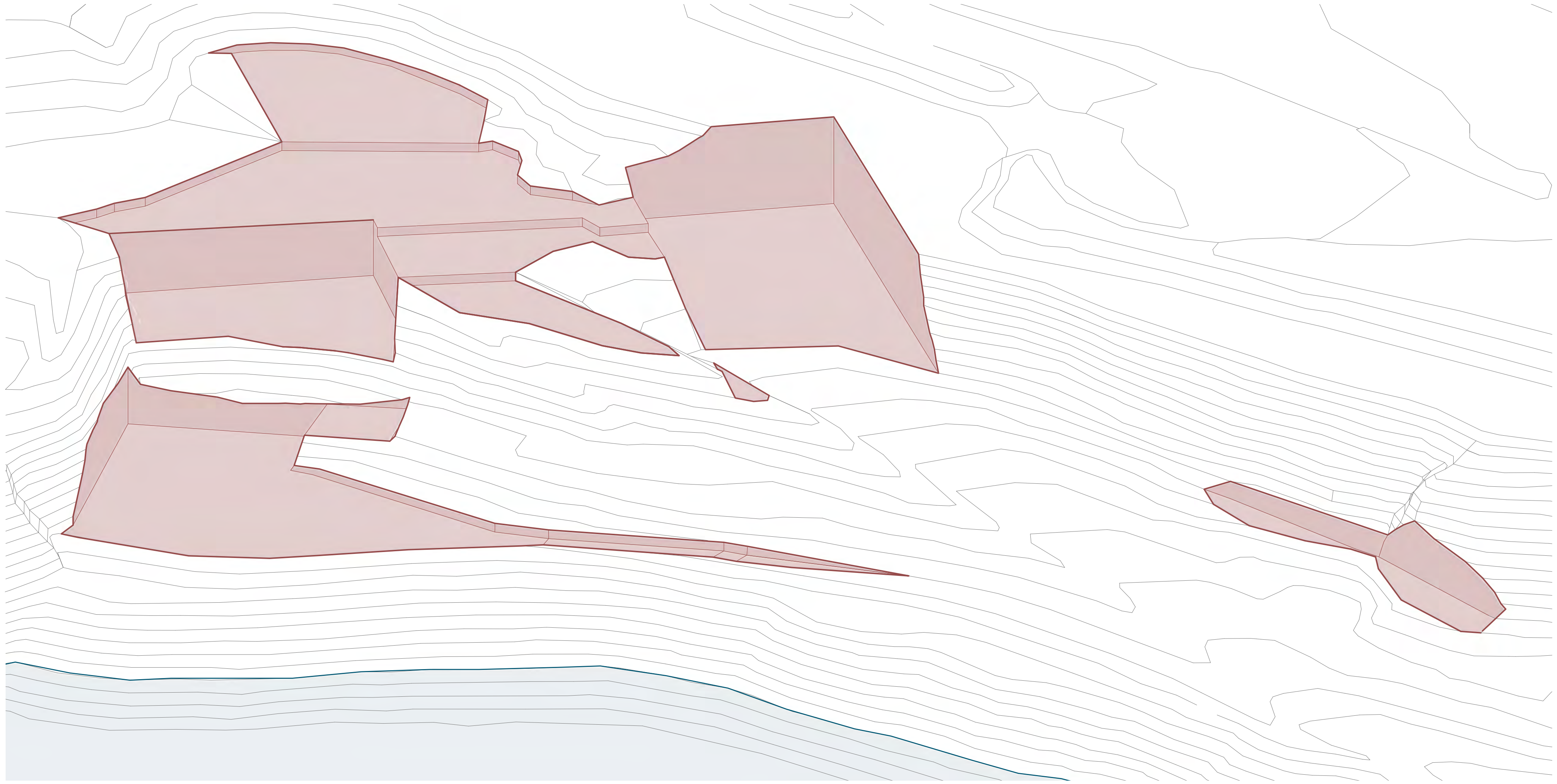


Fig 76; Site Cut Axonometric 1.1500

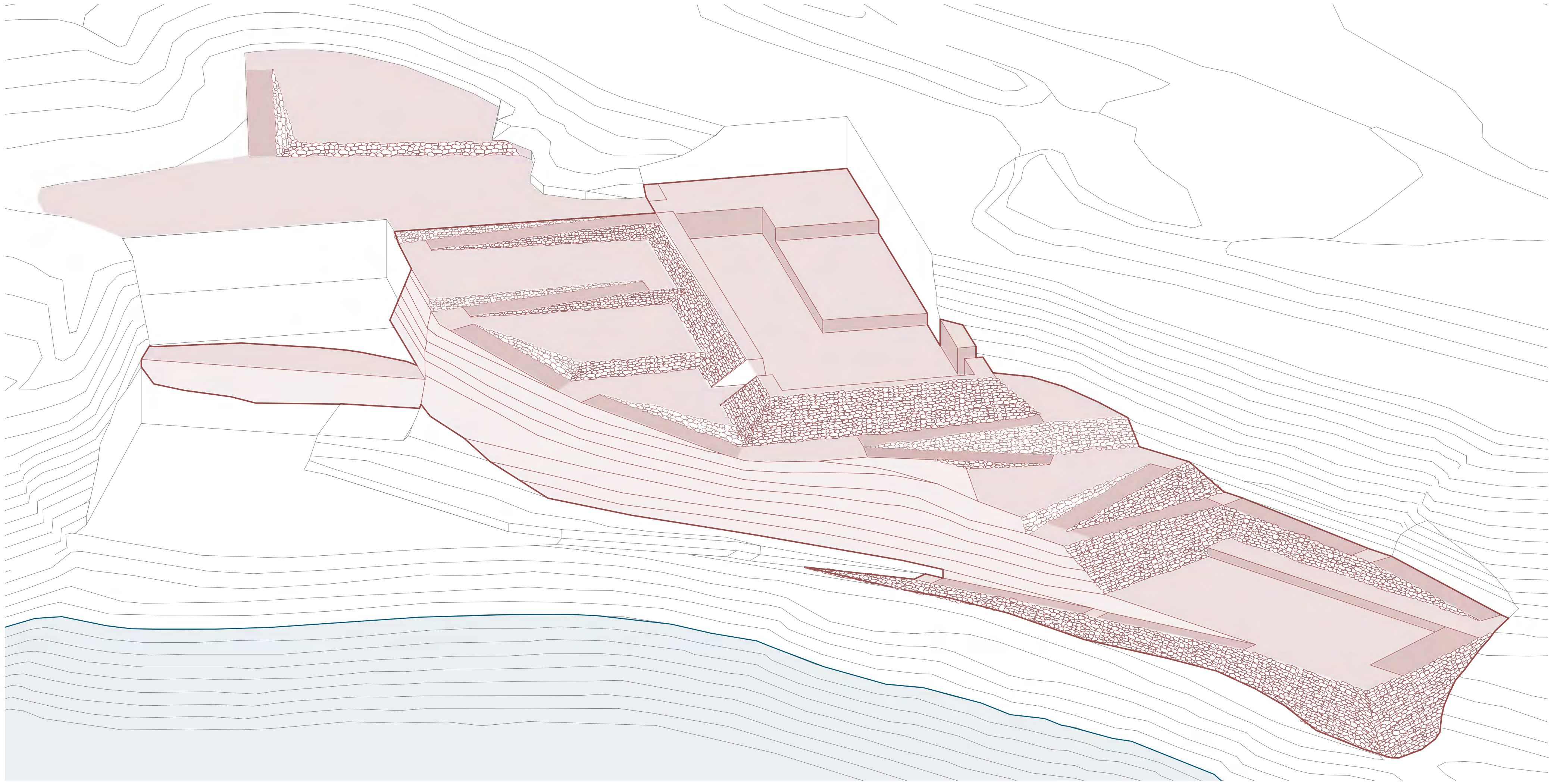


Fig 77; Site Fill Axonometric 1.1500

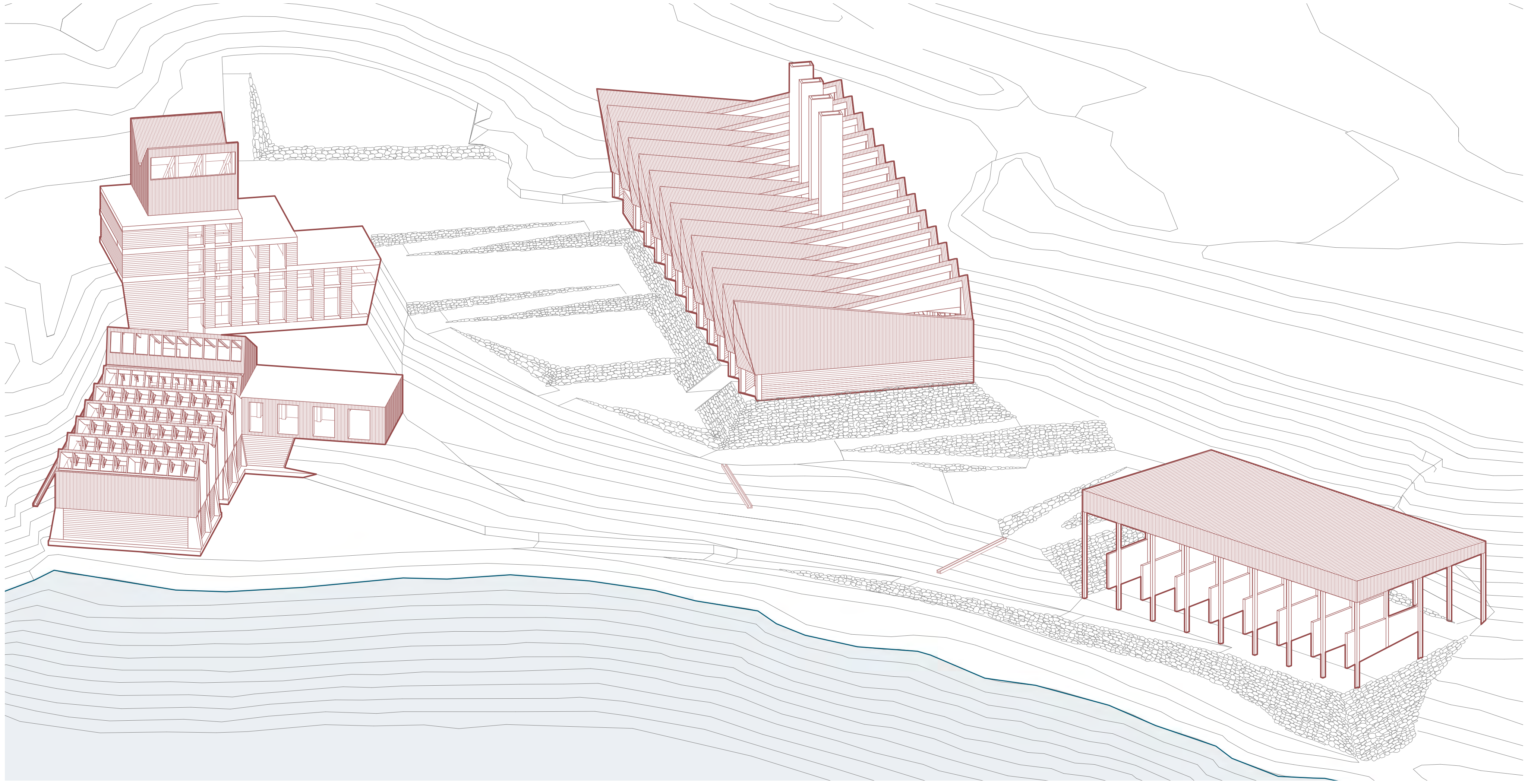


Fig 78; Building Form Axonometric 1.1500

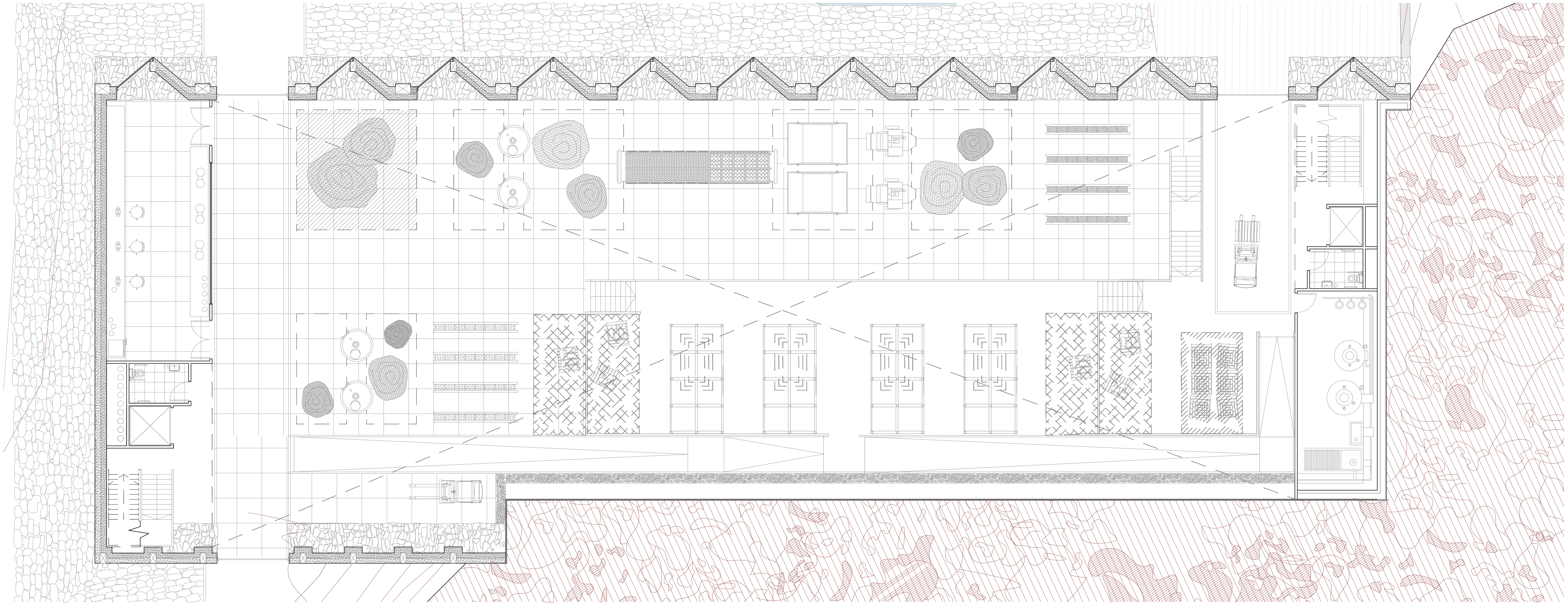


Fig 79; Manufacture Building Ground Floor Plan

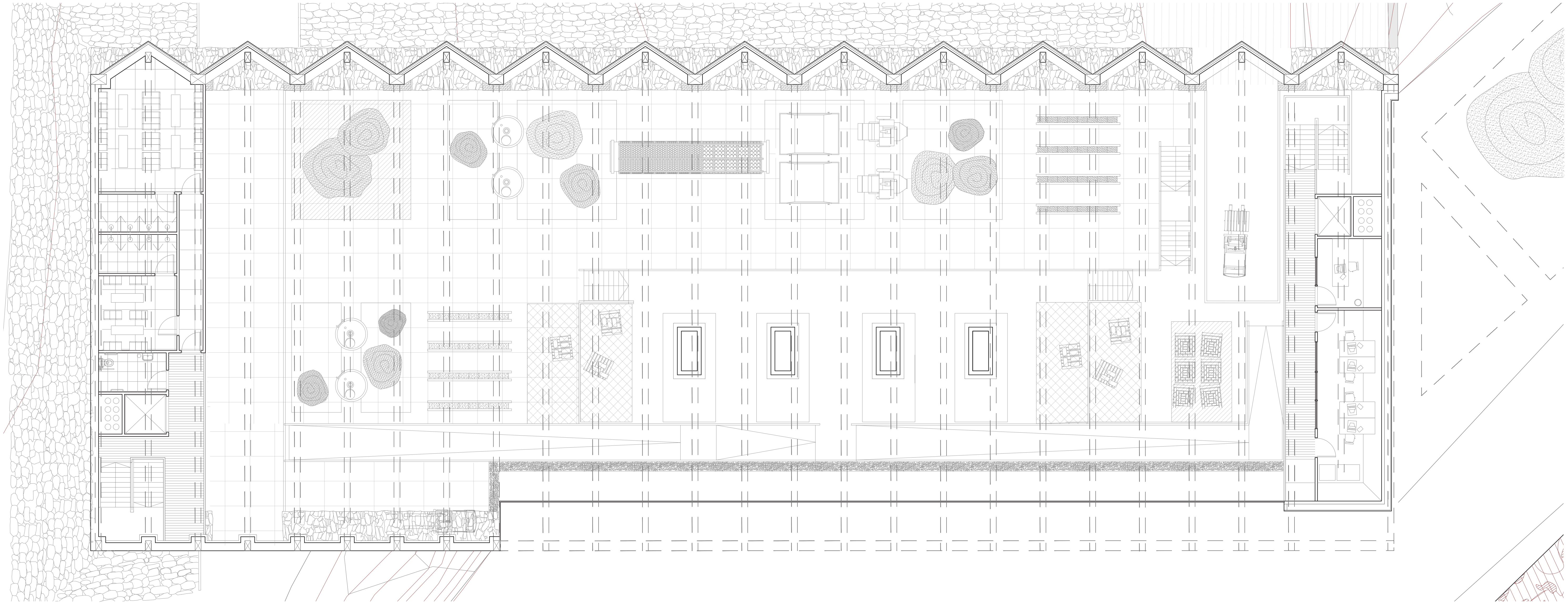
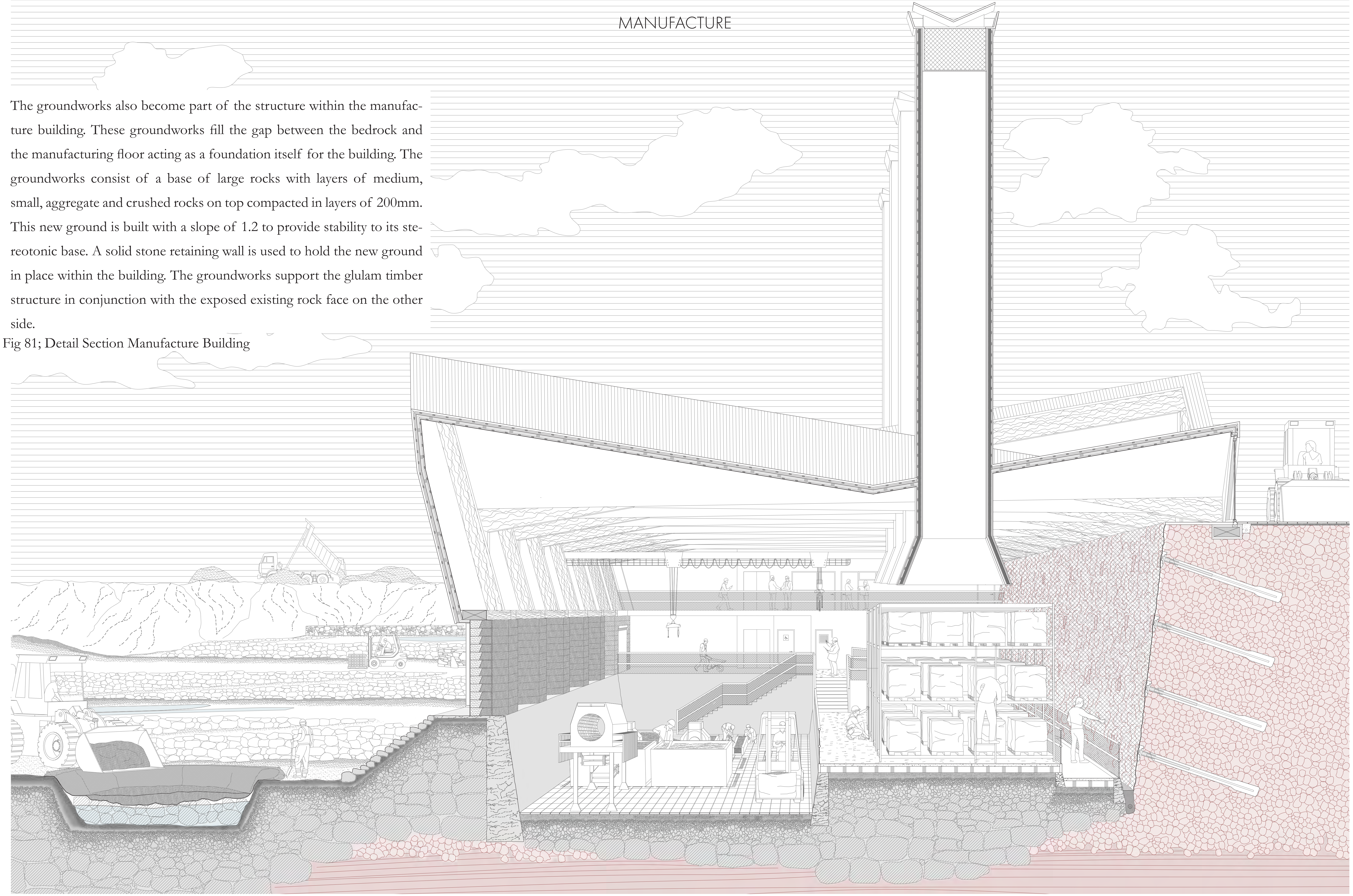


Fig 80; Manufacture Building First Floor Plan

The groundworks also become part of the structure within the manufacture building. These groundworks fill the gap between the bedrock and the manufacturing floor acting as a foundation itself for the building. The groundworks consist of a base of large rocks with layers of medium, small, aggregate and crushed rocks on top compacted in layers of 200mm. This new ground is built with a slope of 1.2 to provide stability to its stereotonic base. A solid stone retaining wall is used to hold the new ground in place within the building. The groundworks support the glulam timber structure in conjunction with the exposed existing rock face on the other side.

Fig 81; Detail Section Manufacture Building



REFLECTION

Regarding the scale of my thesis, I felt it was not feasible to address each component within my design project as thoroughly as I would of liked. Upon reflection, with more time, I would develop my learning network building further with more regard to the human feeling of moving through these spaces to create an educational journey stepping down the site. While I focused on the spaces materiality and structure, I would of taken more consideration of the specific views each space would have and sought to align the views with the manufacturing platforms that run adjacent to the building allowing the occupants to enjoy passive learning from the earth block manufacture process.

Based on my thesis research and analysis, my main challenge was to find a new way of considering material production, one which reflects my objectives through the lens of design, mediating a position between locality and global industry. However, meeting this goal will require co-ordination across a body of sectors from designers to the strategic development of regional supply chains. As architects, we must have the freedom to grow and change, learning as our buildings learn. We should not consider ourselves just the designer of a building, but a key player in all the processes of place making.

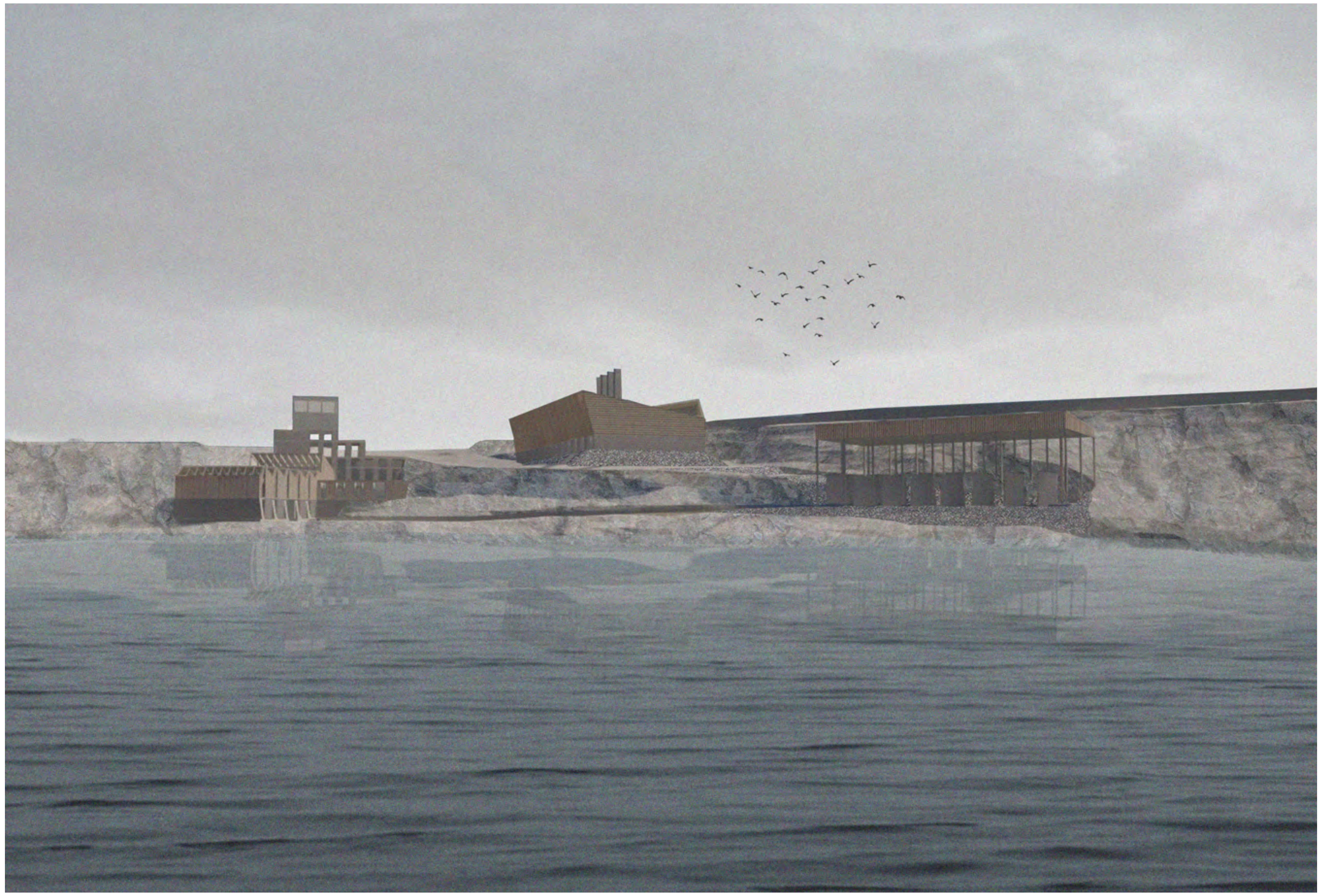


Fig 82; Render of Proposed Site

BIBLIOGRAPHY

Byggeriets materialepyramide (no date) Byggeriets Materialepyramide. Available at: https://www.materialepyramiden.dk/ (Accessed: January 2, 2023).

Calder, B. (2022) Architecture from prehistory to climate emergency. (Introduction) London: Pelican an imprint of Penguin Books.

Cohalan, D. (2018) "Innovative CLT timber to deliver profit boost for forestry sector," Irish Examiner, 26 April.

De Cooman, K. (2019) "Beyond Critical Regionalism Grey Zones and Radicality in Contemporary Practice," OASE Critical Regionalism Revisited, May, pp. 137–141.

Duperrex, M. (2020) Landscape and hybrid sedimentology, Critical Zones. The Science and Politics of Landing on Earth. Available at: https://www.academia.edu/44125015/Landscape_and_Hybrid_Sedimentology (Accessed: January 2, 2023).

Editors, A.R. (2022) CCA x AR Ecologies: How to do no harm, Architectural Review. Available at: https://www.architectural-review.com/podcasts/ar-ecologies/cca-x-ar-ecologies-how-to-do-no-harm?eea=RHNGb3RvWjF3MzBhdnlnMjRkTTF2aXM5UmlTVDBSYzZkNEdlaVBqRE1pOD0%3D&utm_source=acs&utm_medium=email&utm_campaign=FABS_AR_EDI_REG_Podcast_20221029&deliveryName=DM89564 (Accessed: November 29, 2022).

Environmental Consulting Company (2017) Review of Soil Waste Managment in the Greater Dublin Area Market: Analysis Report. Dublin: EPA.

Forward to the stone age? (2020) RIBA. Available at: https://www.architecture.com/knowledge-and-resources/knowledge-landing-page/forward-to-the-stone-age (Accessed: November 29, 2022).

Gibson, G. (host) (2021) Amin Taha on Stone. GrantOnDesign. Available at: https://grantondesign.com/Amin-Taha (Accessed: November 29, 2022).

Hutton, J.E. (2020) Reciprocal landscapes: Stories of material movements. (p1-15) Londres: Routledge, an imprint of the Taylor & Francis Group.

Ireland, E.P.A. (no date) EPA Maps. Available at: https://gis.epa.ie/EPAMaps/ (Accessed: November 29, 2022).

Islam, S., Gormley, P. and Massoud, G. (2022) 'Demolitan', in Material reform: Building for a post-carbon future. London: MACK.

Islam, S., Gormley, P. and Massoud, G. (2022) 'Soil', in Material reform: Building for a post-carbon future. London: MACK.

Islam, S., Gormley, P. and Massoud, G. (2022) 'Supply Chains', in Material reform: Building for a post-carbon future. London: MACK.

Jackson, P.W. (1993) The building stones of Dublin: A walking guide. (p21-32) Dublin, Ireland: Town House and Country House.

Kahn, A. and Burns, C. (2021) Site matters: Strategies for uncertainty through planning and Design. (p87-100,p110-129) London, England: Routledge.

Kimmerer, R.W. et al. (2015) Braiding Sweetgrass for Young Adults: Indigenous Wisdom, scientific knowledge, and the teachings of plants. (p116) Minneapolis, MN: Zest Books, an imprint of Lerner Publishing Group, Inc.

Latour, B. and Weibel, P. (2020) Critical zones: The science and politics of landing on Earth. Cambridge, Mass: MIT Press

Leatherbarrow, D. (2014) "Materials Matter," in Architecture oriented otherwise. (p80) Princeton Architectural.

Lefaivre, L. and Tzonis, A. (2003) Critical regionalism: Architecture and identity in a Globalized World. Munich etc.: Prestel.

Lovelock, J.E. (1995) Gaia: A new look at life on Earth. Oxford England: Oxford University Press.

Mindrup, M. and Winton, T.E. (2017) "Mythic Geology: Under the Surface at Palazzo del Te," in Material imagination: Reveries on architecture and matter. (p70) ROUTLEDGE.

Oosterheerd, I. (2021) “Soil Matters,” BioDivercity_A matter of vital soil!

Oosterheerd, I. (2021) “Urban Soils,” BioDivercity_A matter of vital soil!

Pranvera (2018) Dublin – a city of wetlands, HorticultureConnected.ie. Available at: https://horticultureconnected.ie/horticulture-connected-print/2016/spring-16/dublin-a-city-of-wetlands/ (Accessed: November 29, 2022).

Rael, R. (2009) Earth architecture. (p9-15) New York, NY: Princeton Architectural Press.

Teerds, H. (2019) “Borrowing, Stacking, Referring, Intertwining A Conversation with Lilith van Assem and Elsbeth Ronner,” OASE Critical Regionalism Revisited, May, pp. 133–136.

The Oxford Dictionary (1992). Oxford: Oxford University Press.

Viganò , P. et al. (2022) “Exploring the Soil: Not a Sentimental Journey,” OASE, 22 January, pp. 5–15.

Williams, F. (2021) Saving the earth: Making the case for rammed Earth Architecture, The Architects’ Journal. Available at: https://www.architectsjournal.co.uk/specification/saving-the-earth-making-the-case-for-rammed-earth-architecture (Accessed: December 31, 2022).

Woodworks, V.D.M.A. (no date) Mass timber, Manufacture of mass timber: glued laminated timber (glulam), cross laminated timber (CLT). Available at: https://processing-wood.com/processes/mass_timber/ (Accessed: January 2, 2023).

Bunschoten, R. (1992) Raoul Bunschoten: The Skin of the Earth. Århus: Arkitekturtidsskrift.

Frampton, K. (2020) Modern Architecture: A critical history. London: Thames and Hudson.

Lefaivre, L. and Tzonis, A. (2021) Architecture of regionalism in the age of globalization: Peaks and valleys in the flat world. New York, NY: Routledge.

Peter Harnik, M.T. (2006) From dumps to destinations: The conversion of landfills to Parks, Places Journal. Available at: https://placesjournal.org/article/from-dumps-to-destinations-the-conversion-of-landfills-to-parks/ (Accessed: January 1, 2023).

Rogers, R. and Gumuchdjian, P. (1998) Cities for a small planet. Boulder: Westview print.

Turpin, E. (2013) Architecture in the anthropocene: Encounters among design, Deep Time, science and philosophy. Open Humanities Press.

TABLE OF FIGURES

All images, drawings and photographs are authors own unless unless otherwise specified. See below table for referenced images:

Fig.1 - Heritage, Glasnevin (2015) Finglas Dump, Facebook Available at: https://www.facebook.com/GlasnevinHeritage/photos/a.182651638552178/539008529583152/?type=3

Fig. 7 - Arenes, A. (2022) Design at the time of the anthropocene: Reporting from the critical zone, Research Explorer The University of Manchester. Available at: https://research.manchester.ac.uk/en/studentTheses/design-at-the-time-of-the-anthropocene-reporting-from-the-critica (Accessed: 18 May 2023).

Fig. 8 - Kahn, A. and Burns, C. (2021) Site matters: Strategies for uncertainty through planning and Design. London, England: Routledge.

Fig. 9 –Anas et al. (2023) Raw material: Extraction, classification and characteristics, crgsoft.com. Available at: https://crgsoft.com/raw-material-extraction-classification-and-characteristics/ (Accessed: 18 May 2023).

Fig. 10 – Publisher, W. (2021) PPA Eyes more green initiatives for sustainable port operations, PortCalls Asia. Available at: https://www.portcalls.com/ppa-green-initiatives-sustainable-port-operations/ (Accessed: 18 May 2023).

Fig. 11 – Eminton, S (2019) EMR aiming to be 'global leader' in Sustainability, letsrecycle.com. Available at: https://www.letsrecycle.com/news/emr-global-leader-sustainability/ (Accessed: 18 May 2023).

Fig. 13 – Quigley, S. (2022) Stage 3_ Part 1 Groupwork 'Reclamation Realm', Material Inventory

Fig. 14 –Korta, K and Quigley, S (2022) Stage 3_ Part 1 Groupwork 'Reclamation Realm', Colman Factory Axonometric.

Fig. 16 - Quigley, S. (2022) Stage 3_ Part 1 Groupwork 'Reclamation Realm', Proposed Plan

Fig. 19 – MacLeod, F. (2019) The 'Manhattan of the Desert': Shibam, Yemen's ancient Skyscraper City, ArchDaily. ArchDaily. Available at: https://www.archdaily.com/771154/the-manhattan-of-the-desert-shibam-yemens-ancient-skyscraper-city (Accessed: January 1, 2023).

Fig. 20 - Admin (2007) Frank Lloyd Wright Rammed earth, EARTH ARCHITECTURE. Available at: http://eartharchitecture.org/?p=390 (Accessed: January 1, 2023).

Fig. 29 – Laka, S. (2022) Images taken on site.

Fig. 30 – McNamee, M. (2015) The disused quarry in Dublin might be turned into a waste storage facility, TheJournal.ie. Available at: https://www.thejournal.ie/quarry-disused-waste-facility-skerries-outside-1923729-Feb2015/ (Accessed: 18 May 2023).

Fig. 31 – Geosolutions (2020) Quarry reclamation / inert debris fill, HD Geosolutions. Available at: https://hdgeosolutions.com/service/quarry-reclamation/ (Accessed: 18 May 2023).

Fig. 33 – Kan, K. (2021) Meet BC Materials, turning your building site into beautiful building materials, Zero waste, no transportation, fully circular, KANKAN. Available at: https://www.kankan.london/blogs/stories-by-yes-you-on-medium/meet-bc-materials-turning-excavated-waste-into-beautiful-building-materials (Accessed: 18 May 2023).

Fig. 34 – Diederich, L. (2021) BC materials turns excavation waste into sustainable building material, PropTechlab. Available at: https://www.proptechlab.be/bc-materials-turns-excavation-waste-into-sustainable-building-material/ (Accessed: 18 May 2023).

Fig. 35 – soulieres, P., Newcastle, D.R. and Arias-Diez, M.Arch.M. (1967) Building with hempcrete, a10studio. Available at: https://www.a10studio.net/building-hempcrete/ (Accessed: 18 May 2023).

Fig. 39 – Laka, S. (2022) Images taken on site.

Fig. 40 & 41 – Arts, F. (2016) In Huntstown quarry at Cold Winters choosing a 1916 memorial stone.@fingalcoco @fingalarts @ PIC.TWITTER.COM/RNO541NG0E, Twitter. Available at: https://twitter.com/fingalarts/status/722822190949875712 (Accessed: 18 May 2023).

Fig. 73 & 74 - Frank Lloyd Wright (2019) Taliesin West by Frank Lloyd Wright (659AR) - Atlas of Places. Available at: https://www.atlasofplaces.com/architecture/taliesin-west/ (Accessed: 18 May 2023).

APPENDIX

APPENDIX A: STONE

While stone has been a historically primal material for construction, creating shelter for the millennia, it has been shunned in recent years with the development of concrete and steel structures. We have seen change in this thinking with the nascent movement of the 'New Stone Age' exhibition in London 2020 where they have sought to bring stone to the foreground of modern design. Amin Taha's 15 Clerkenwell Close limestone structure showed an embodied carbon reduction of 90% weighed up against similar concrete or steel structures. Amin Taha's 15 Clerkenwell Close is a housing scheme whose structure is made of raw monolithic quarried limestone. The structure contains eight apartments and his own offices and has tested the limits of limestone in terms of height and fire regulations. His design has brought stone out of just being a decorative material with emphasis on the building's embodied carbon reduction of 90% weighed up against similar concrete or steel structures. (Webb, 2020) In its construction, limestone was imported from France as their stone carvers are still trained to work with superstructure. They combine heritage craft with the modern software of today allowing new technologies to influence traditional skills. (Amin Taha on Stone 2021) The embodied carbon of stone equates to 0.079kg of carbon per kg of stone in comparison to concrete with 0.15kg of carbon per kg and steel with 2.8kg of carbon per kg. While timber is arguably the most sustainable material in terms of its carbon as it sequesters 610 kg of carbon per kg (Byggeriets materialepyramide) in terms of production and manufacture, stone is again lower in comparison with cutting, transportation and erection on site, it's only contributing factors. (Webb, 2020)

The exciting element of stone is it's finished elevations are not revealed until it is on site. It is impossible to draw the construction image as raw stone is never the same. In limestone, as it is a sedimentary stone, when spilt it reveals layers of fossils within. Amin Taha's building left the limestone face of the column and beams in its human influenced state from extraction making a feature of its variety of textural finishes. (Gibson, 2021) This way of working brings to mind an old thought of architecture as being expressive materiality. In the 17th century "architect's argued that the beauty of the building could be positively determined by the richness of its materials" (Leatherbarrow, p80. 2014) but what if this richness could come from the dialogue between the materials inward organisation and the marks of human hands on the architectural surface. Stone with its varying natural lines of cleavage is already a form itself that has responded to an outward order caused by human action or erosion from the elements. In turn, creating material beauty that allows us as architects to respond. This establishes discourse between the 'outward' laws of craft we use to create components and the hermetic laws of nature of the material. (Mindrup & Winton, 2017)

So why is structural stone not in production? While it is plentiful and easily accessible in certain areas of the world, architects and engineers are hesitant as they lack the training and design codes to apply it. It is under regulated regarding fire thus bringing with it a degree of risk as tests must be carried out on site during construction. (Webb, 2020) Stone cutters and quarry workers of today work with ornamentation and cement manufacture therefore are not equipped for large scale production of structural elements. Within stone production, it is crucial to know the material's origin in order to lower the possibility of exposure to unethical practices within the global supply chain as much stone production comes from unregulated quarries (Forward to the stone age? 2020) Materials have become detached from locality through the global circulation of matter driven by capitalism, with no questions asked of where they came from or what they have left behind. Their origin landscapes is seen as nothing more than natural resources, dormant landscapes for the taking. (Hutton, 2020)

APPENDIX B: CRITICAL REGIONALISM

An architectural school of thought that strives to create a deeper understanding of site and locality is critical regionalism. Introduced as an alternative to the post-modern movement, it centered its theory around identity of place. Instead of the universal, reductive methods of concrete or steel construction brought to fruition within the modernist and post-modernist eras, its form and materiality generated from the specifics of an individual situation, recognizing the individuality of a cultural, social and physical site rather than senselessly imposing methods of globalisation. It rethinks architecture through the concept of region, whether this concerned intricate human relations or the equilibrium of the ecosystem, in turn fighting against universalisation of the built environment to sustain multiplicity within architecture. (Lefaivre & Tzonis, 2003)

As a young architect, Frampton's teachings are already a common practice in my designs, his teachings favourable rather than innovative but still extremely relevant in an increasingly globalised world where entertainment and commodities have become increasing important within architecture culture. (Teerds, 2019) This is seen in the emergence of facadism where historic walls hide vast new office spaces behind their skin and through the use of timber facades to conceal steel and concrete frames giving an impression of sustainability. (Wilson & Jennings, 2016)Capital has become the principal player. It appears that it is the image of architecture is what has become important, seen in the computer generated images of new developments dominating news articles, site hoardings and brochures. Architecture determined by its aesthetic while its construction is an afterthought. These buildings, in architectural representations of the future, are imagined with monumental permanence with no acknowledge of their decay, age or redundancy over time. (Wilson & Jennings,

2016) But how do we go about representing a world that we cannot predict? A world that will be fundamentally different from the one we are designing in?

We may consider critical regionalism with different intentions. We must mediate a position between local and global, creating a level of resistance without regression by considering the same pillars of critical regionalism, climate, tectonics, context, topography, light and place but rather for the wellbeing of our planet instead of opposing the 'phenomenon of universalisation'. (De Cooman, 2019) We ought to add new global pillars such as the impact of our designs on our world and our ever changing ecosystems due to resource depletions and climate change. Thus, creating a new architecture of realism centered around critical globalism.